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# SUBSONIC AERODYNAMIC CHARACTERISTICS OF INTERACTING LIFTING SURFACES WITH SEPARATED FLOW AROUND SHARP EDGES PREDICTED BY A VORTEX-LATTICE METHOD

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# SUBSONIC AERODYNAMIC CHARACTERISTICS OF INTERACTING LIFTING SURFACES WITH SEPARATED FLOW AROUND SHARP EDGES PREDICTED BY A VORTEX-LATTICE METHOD

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## SUMMARY

Because the potential flow suction along the leading and side edges of a planform can be used to determine both leading- and side-edge vortex lift, the present investigation was undertaken to apply the vortex-lattice method to computing side-edge suction force for both isolated and interacting planforms. Although there is a small effect of bound vortex sweep on the computation of the side-edge suction force, the results obtained for a number of different isolated planforms produced acceptable agreement with results obtained from an application of the suction analogy to a method employing continuous induced-velocity distributions. The computed side-edge suction results generally remained within 1 percent of the converged ones for 6 singularities chordwise at each of 20 spanwise locations.

The lift characteristics obtained from the present method for several isolated wings agreed as closely with experimental data as did those obtained from the method employing continuous induced-velocity distributions. In addition, by using the method outlined in this report, better agreement between theory and experiment was noted for a wing in the presence of a canard than had previously been obtained.

## INTRODUCTION

The development of methods for predicting the aerodynamic characteristics of aircraft, which during portions of their flight envelopes, develop separated flow with reattachment around the leading and side edges of the wing, has been the subject of studies for many years and has had varying degrees of success. Polhamus in references 1, 2, and 3 provided a method by which the effects of separated flow around a sharp leading edge on lift and drag could be estimated by an analogy that relates these forces to the attached flow leading-edge suction force. Hence, current lifting-surface computer programs which estimate leading-edge suction are useful in predicting the leading-edge separation effects on the forces.

The effects of side-edge separation on the aerodynamic characteristics have been estimated by determining the attached flow side force and then employing a "suction analogy" similar to that used at the leading edge. This concept was developed and correlated with experiment and other methods in reference 4. The procedure employed in reference 4 is based on a modified Multhopp method which is outlined in reference 5.

The technique of reference 4 is well suited to single, isolated planforms. However, for lifting planforms in combinations or for flat body-wing configurations, the vortex-lattice method (i.e., ref. 6) is better suited because its elemental panel representation provides a straightforward extension to the more complex configurations.

This paper is concerned with the extension of the vortex-lattice method of reference 6 to the computation of the attached flow side force. Others have published similar work recently (refs. 7, 8, and 9, for example) but they do not provide comparisons of alternate paneling arrangements or convergence studies with their analyses. Thus, the purposes of this paper are (1) to provide comparisons of alternate paneling arrangements, (2) to provide convergence studies, (3) to provide the details of side-force and pitching-moment computation, and (4) to present comparisons between experimental and theoretical results for single planform configurations and interacting planform configurations.

The program changes made in Langley computer program A2794 since the publication of reference 6 are discussed in appendix A. These changes include corrections, improvements, and the additions relating the the side-edge-suction computations. In addition, input and output data for a sample case are presented in appendix B, and a listing of the program is provided in appendix C.

## SYMBOLS

$A$ aspect ratio

$b$ wing span

$C_D$ drag coefficient, $\frac{\text{Drag}}{q_\infty S_{ref}}$

$C_{D,o}$ experimental value of drag coefficient at $C_L = 0$

$C_L$ lift coefficient, $\frac{\text{Lift}}{q_\infty S_{ref}}$

$C_m$ pitching-moment coefficient about $\bar{Y}$ axis, $\frac{\text{Pitching moment}}{q_\infty S_{ref} c_{ref}}$

$\Delta C_{m,i}$ contribution to pitching-moment coefficient from vortex system operating on an elemental panel

$C_N$ normal-force coefficient, $\frac{\text{Normal force}}{q_\infty S_{ref}}$

$C_S$ total leading-edge suction-force coefficient, $\frac{2(\text{Leading-edge suction force on one panel})}{q_\infty S_{ref}}$

$C_{Y,se}$ twice total side-edge-suction-force coefficient of one wing panel, $\frac{2(\text{Side force along side edge on one wing panel})}{q_\infty S_{ref}} = 2 \sum_{i=1}^{N/2} (\Delta C_{Y,se})_i$

$(\Delta C_{Y,se})_i$ contribution to side-edge-force coefficient from ith elemental panel

$c_{ref}$ reference chord

$c_t$ tip chord

$\Delta F_{Y,i}$ contribution to side force from ith elemental panel

$K_p$ $= \frac{\partial C_N}{\partial(\sin \alpha \cos \alpha)}$

$K_{v,le}$ $= \frac{\partial C_S}{\partial \sin^2 \alpha}$

$K_{v,se}$ $= \frac{\partial C_{Y,se}}{\partial \sin^2 \alpha}$

$l$ length of trailing filament between adjacent chordwise horseshoe vortices

$\Delta l$ bound vortex filament length in chord direction

M Mach number

| | |
|---|---|
| $N$ | total number of horseshoe vortices that contribute to the side-edge suction force |
| $\overline{N}_c$ | number of elemental panels in chordwise row |
| $\overline{N}_s$ | number of chordwise rows on wing semispan |
| $q_\infty$ | free-stream dynamic pressure |
| $S_{ref}$ | reference area |
| $U$ | free-stream velocity |
| $w$ | induced downwash velocity |
| $X,Y,Z$ | axis system of a given horseshoe vortex (see fig. 1) |
| $\overline{X},\overline{Y},\overline{Z}$ | body-axis system for planform input (see fig. 1) |
| $\overline{x},\overline{y}$ | distance along $\overline{X}$- and $\overline{Y}$-axis, respectively |
| $x_{ref}$ | moment reference point (taken to be zero herein) |
| $\Delta x$ | distance along tip chord to centroid of side-edge force |
| $\Delta x'$ | chordwise distance from midpoint of particular vortex filament to moment reference point |
| $\alpha$ | angle of attack, deg |
| $\beta$ | $= \sqrt{1 - M^2}$ |
| $\Gamma$ | vortex strength |
| $\Gamma'$ | chordwise sum of vortex strengths to a particular elemental panel, $\Sigma\Gamma$ (see fig. 1) |
| $\Lambda$ | leading-edge sweep angle, positive for sweepback, deg |

$\lambda$ taper ratio

$\rho$ density

$\psi$ sweep angle of bound vortex, deg

Subscripts:

B bound vortex

c centroid

i particular horseshoe vortex

j particular item of location

L left

$le$ leading edge

p potential or attached flow

R right

se side edge

tot total

$vle$ vortex effect at leading edge

vse vortex effect at side edge

## THEORETICAL DEVELOPMENT

The attached flow side force is developed in accordance with the Kutta-Joukowski law for forces generated by a vortex filament. Figure 1 shows vortex filaments which have a streamwise component interacting with the net downwash at the filament midpoint to produce an elemental side force. The net side force on an elemental panel due to a swept horseshoe vortex system on the left wing panel is

$$\Delta F_{y,i} = \rho \left\{ \Gamma' \left[ (w_L - U\alpha) l_L - (w_R - U\alpha) l_R \right] + \frac{|\tan \psi|}{\tan \psi} \Gamma (w_B - U\alpha) \Delta l \right\}_i \tag{1}$$

and the contribution to the side-force coefficient is

$$(\Delta C_{Y,se})_i = \frac{2}{S_{ref}} \left\{ \frac{\Gamma'}{U} \left[ \left( \frac{w_L}{U} - \alpha \right) l_L - \left( \frac{w_R}{U} - \alpha \right) l_R \right] + \frac{|\tan \psi|}{\tan \psi} \frac{\Gamma}{U} \left( \frac{w_B}{U} - \alpha \right) \Delta l \right\}_i \tag{2}$$

The side force is of order $\alpha^2$, which is appropriate since it is associated with edge suction. If the trigonometric terms were retained, the side force is actually a function of $\sin^2 \alpha$ since the $\alpha$ term is really a $\sin \alpha$ term and $\Gamma/U$, $\Gamma'/U$, and $w/U$ are all proportional to $\sin \alpha$ for the wind and body axes coincident. Hence, $K_{v,se}$ can be formulates as

$$K_{v,se} = \frac{\partial \left[ 2 \sum_{i=1}^{N/2} (\Delta C_{Y,se})_i \right]}{\partial \sin^2 \alpha} \tag{3}$$

For small $\alpha$ the $\sin \alpha \approx \alpha$ which, for numerical purposes, is taken to be 1 radian in equations (2) and (3) and leads to

$$K_{v,se} = 2 \sum_{i=1}^{N/2} (\Delta C_{Y,se})_i \tag{4}$$

This provides an additional contribution to the total lift, as indicated in the following equation:

$$C_{L,tot} = \overbrace{K_p \sin \alpha \cos^2 \alpha}^{C_{L,p}} + \overbrace{K_{v,le} |\sin \alpha| \sin \alpha \cos \alpha}^{C_{L,vle}} + \overbrace{K_{v,se} |\sin \alpha| \sin \alpha \cos \alpha}^{C_{L,vse}} \tag{5}$$

For planforms having sharp edges, the drag coefficient can be written as

$$C_D = C_{D,o} + C_{L,tot} \tan \alpha$$

In the numerical determination of the side force, it is realized that computational time savings could be made with the utilization of a swept horseshoe vortex system. The savings are due to the vortex filament length and the net downwash associated with the right trailing filament of a swept horseshoe vortex being the same as those for the left trailing filament on the adjoining inboard swept horseshoe vortex. However, the swept bound vortex may lead to local and overall errors in the side force, just as it did for leading-edge thrust[1] (ref. 10). This potential problem will be investigated although it should be less serious than that for thrust because in the side-force computation, the bound vortex interaction with the net downwash at its midpoint will only contribute a portion to the total side force, rather than the entire result.

To assess the importance of the inclusion of the swept bound vortex, numerical studies are presented in the next section. They are based on paneling the wing in various ways to emphasize the influence of the bound vortex differently.

The pitching-moment contribution about the $\overline{Y}$-axis associated with the side-edge-suction force is determined from each elemental horseshoe vortex by

$$\Delta C_{m,i} = \frac{2}{S_{ref}} \frac{1}{c_{ref}} \left\{ \frac{\Gamma'}{U} \left[ -\left(\frac{w_L}{U} - \alpha\right) l_L \, \Delta x'_L + \left(\frac{w_R}{U} - \alpha\right) l_R \, \Delta x'_R \right] - \frac{|\tan \psi|}{\tan \psi} \frac{\Gamma}{U} \left(\frac{w_B}{U} - \alpha\right) \Delta l \, \Delta x'_B \right\}_i$$

The sign of each term is chosen with the realization that the overall rotation of the trailing flow field on the left wing panel is clockwise as viewed from the rear. This rotation causes the vortex elements behind the moment reference point to contribute a noseup moment if associated with the left trailing leg or a sweptback bound vortex and a nosedown moment for the vortex elements associated with the right trailing leg (fig. 1). The total pitching moment is obtained by using the following expression:

$$C_{m,p} \qquad\qquad C_{m,vle} \qquad\qquad C_{m,vse} = \left( 2 \sum_{i=1}^{N/2} \Delta C_{m,i} \right) |\sin \alpha| \sin \alpha$$

$$C_{m,tot} = \overbrace{K_p \sin \alpha \cos \alpha \frac{\tilde{x}_{c,p}}{c_{ref}}}^{} + \overbrace{K_{v,le} |\sin \alpha| \sin \alpha \frac{\tilde{x}_{c,le}}{c_{ref}}}^{} + \overbrace{K_{v,se} |\sin \alpha| \sin \alpha \frac{\tilde{x}_{c,se}}{c_{ref}}}^{}$$

when the particular $\tilde{x}_c$-terms equal $x_{ref} - x_{c,j}$.

Only those horseshoe vortices or portions thereof which would intersect the side edge if they were projected laterally to the local spanwise extent of the planform (those

[1]The leading-edge thrust problem and the program changes made to correct it are described in appendix A.

that do so are said to directly oppose the side edge) are included in the summation for the side force and pitching moment. This procedure is the same as that used for computing the leading-edge thrust, where all the distributed thrust along the chord is projected forward and assumed to act at the leading edge. One reason for computing the side-edge suction force in this manner, rather than with the method presented in reference 8, is that, in the application of the method of reference 8 to a cropped diamond wing, the entire side-edge suction force would be calculated over a wing panel with the only reduction coming from the removal of the contribution from the leading-edge suction. This retains the contribution to the side force from the aft part of the cropped delta wing from which no edge force is expected.

## NUMERICAL STUDIES

### Panel Arrangements

Table I presents a comparison of $K_{v,se}$ and the side-edge load centroid obtained by four different methods for the three wing planforms presented in figure 2. Method 1 is the continuous loading method of reference 4 and the results of this method are taken to be the standard. Method 2 is the present method, which was described previously. Method 3 is the same as method 2 except each planform is considered as two wings (the dashed lines in fig. 2 show break lines) and the side-edge suction force is computed only on the aft wing. Method 4 is the vortex-lattice method described in reference 7 with the results being supplied by R. G. Bradley of General Dynamics Corp.

The layout of the bound vortices directly opposing the side edge of a wing tip will have less sweep for method 3 than for method 2 because method 3 panels the wing as two planforms. In fact the cropped delta wing is a special case for method 3 since the bound vortices inboard of the wing tip have no sweep. By comparison, the results of method 3 agreed more closely with the continuous induced-velocity approach of reference 4 (method 1) than the results of method 2. The results from method 3 for the cropped delta wing agreed closest with method 1. This agreement indicates that there is an effect of bound vortex sweep on $K_{v,se}$; however, the maximum difference between the results of method 2 and those of method 1 for the configurations shown in table I was only about 4 percent for $K_{v,se}$ and about 4 percent for the centroid location. The table also shows that the results of method 4 (ref. 7) are somewhat higher than those of method 1.

In an effort to study further the effect of bound vortex sweep angle on $K_{v,se}$ and its chordwise centroid, results were obtained for a rectangular wing sheared to various sweep angles; these results are presented in table II. The reason for selecting this type of planform was to provide a critical evaluation of method 2, since the bound vortex sweep angles will all be (1) the same, (2) maximum for the planform, and (3) equal to that of the

leading edge. For any other simple planform, discounting those with reversed taper, the bound vortex sweep angles would become less positive the closer the vortices are located to the trailing edge. Increasing the leading-edge sweep angle in this manner leads to a reduced number of horseshoe vortices that directly oppose the side edge and that can make a contribution to side force or its moment. Table II shows that, in general, the $K_{v,se}$ values and chordwise centroid locations of method 2 are smaller and more forward, respectively, than those of method 1. The maximum percent errors are 9.4 for $K_{v,se}$ and 9.8 for $\Delta x/c_t$ in terms of $c_t$. The highest sweep angle reported in this study was 75° because for higher sweep angles method 1 was unable to determine a suitable control point pattern to insure a valid logarithmic singular correction.

Method 2 is chosen in this paper as the method to be used in subsequent calculations and will be designated as present method because it allows the analysis of two wings in the presence of each other (for example, a canard-wing configuration), whereas method 3 does not. Another reason is that the values of $K_{v,se}$ presented in table I, as determined by the four methods, have only small differences and the effect on the total lift answer would amount to less than a 4-percent maximum error for angles of attack up to 30°.

Table III presents a comparison of $K_p$, $K_{v,le}$, and $K_{v,se}$ as computed by the present method and method 1 (ref. 4) for several different aspect-ratio rectangular wings and the three wing planforms shown in figure 2. There is seen to be good agreement between the two methods. As the aspect ratio for the rectangular wings approaches zero, $K_{v,se}$ is less than $\pi$ for the present method and greater than $\pi$ for method 1. Reference 4 shows for rectangular wings that as $\beta A$ approaches zero, the theoretical value of $K_{v,se}$ should approach $\pi$.

Values of $\overline{N}_C$ and $\overline{N}_S$ of 6 and 25, respectively, were used in obtaining the results in table III because a preliminary investigation indicated this combination to be adequate. Subsequently, a convergence study was undertaken to determine the minimum requirements of $\overline{N}_C$ and $\overline{N}_S$. The results of this study are discussed in a subsequent section.

## Effect of $\overline{N}_C$ and $\overline{N}_S$

The effect of varying $\overline{N}_C$ and $\overline{N}_S$ on $K_{v,se}$ and $\Delta x/c_t$ is examined herein. The solutions are from the present method and are presented in figures 3 and 4 for isolated planforms. For most of the wings considered in figures 3 and 4, there are many combinations of $\overline{N}_C$ and $\overline{N}_S$ which will yield results within 1 percent of what appears to be the converged values of $K_{v,se}$ and $\Delta x/c_t$. In particular the pattern for $\overline{N}_C = 6$ and $\overline{N}_S = 20$ gives good agreement with the converged result except for the wing with $A = 3.5$ and $\Lambda = 75°$. The vortex-lattice representation for this wing does not provide enough vortices that oppose the side edge for a converged result to be determined with

method 2. This pattern is seen to be larger than the pattern for $\overline{N}_C = 4$ and $\overline{N}_S = 20$, which was determined in reference 6 to be generally adequate to yield acceptable $\partial C_m/\partial C_L$ solutions.

## CORRELATION WITH EXPERIMENT

Figures 5 to 8 present the comparison of the theoretical results obtained by the present method with experimental data obtained from reference 4 for flat rectangular wings with sharp leading and side edges. These wings had aspect ratios of 0.20, 0.40, 1.00, and 3.00. Also, the comparison of theoretical results (present method) with experimental results (ref. 4) for the three swept wings presented in figure 2 is shown in figures 9 to 11. Since the values of $K_{v,se}$ and its chordwise centroid obtained by methods 1 and 2 and reported in table III closely agree, the theoretical results obtained by using the present method should agree as well with the experimental data as did the results of method 1 (ref. 4). As pointed out in reference 4, the reason for the disagreement between experiment and theory shown in figures 9 and 11 is that sweptback wings which have large amounts of area behind the point of maximum span develop lift values in excess of those predicted because of the additional induced effects associated with the actual shed-vortex system. These additional induced effects are the leading-edge vortex acting along the side edge and over the trailing triangular portion of a cropped diamond wing.

Figures 12 to 14 present a comparison of experimental lift (ref. 9) with the present theoretical lift on a wing in the presence of a canard for three different canard configurations: (1) in the wing chord plane, (2) above the wing chord plane, and (3) above the wing chord plane with 18.6° of anhedral. (Only the lift on the portion of the model drawn with solid lines in the sketches in figs. 12 to 14 is plotted.) The addition of the side-edge vortex lift gives better agreement between theory and experiment as compared with that shown in reference 11 for these particular models at angles of attack up to wing stall. The theoretical results presented in reference 11 are replotted in figures 12 to 14 as short dashed lines. It should be noted that the canard data are not presented in this report since the experimental data of reference 11 indicated the canard did not develop full leading-edge vortex lift.

## CONCLUDING REMARKS

Because the potential flow suction along the leading and side edges of a planform can be used to determine both leading- and side-edge vortex lift, the present investigation was undertaken to apply the vortex-lattice method to computing side-edge suction force for isolated or interacting planforms. Although there is a small effect of bound

vortex sweep on the computation of the side-edge suction force, the results obtained for a number of different isolated planforms produced acceptable agreement with results obtained from a method employing continuous induced-velocity distributions. The computed side-edge suction results generally remained within 1 percent of the converged ones for 6 singularities chordwise at each of 20 spanwise locations.

The lift characteristics obtained from the present method for several isolated wings agreed as closely with experimental data as did those obtained from the method employing continuous induced-velocity distributions. In addition, by using the method outlined in this report, better agreement between theory and experiment was noted for a wing in the presence of a canard than had previously been obtained.

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June 19, 1975

## APPENDIX A

## CHANGES, IMPROVEMENTS, AND ADDITIONS TO LANGLEY COMPUTER PROGRAM A2794

The purpose of this appendix is to describe in some detail the changes, improvements, and additions to Langley computer program A2794 of reference 6.

Changes to the input cards of the computer program presented in reference 6 are as follows:

(1) On the configuration card an additional field of 5 has been added (columns 66 to 70) and has a specification of F5.1. This field is used to obtain entry into the tip-suction overlay. By putting a 1. in this field, a tip-suction computation will be made. If this option is not required, the field can be left blank or a 0. put in it.

(2) With the 1. specified in change (1), it is necessary to provide another input data card with a format of 4F10.5. This card contains the limits of "$\bar{y}$-integration" over which the leading-edge suction distribution is to be integrated. Normally these limits would be the plane of symmetry (0.) and the left wing tip (-b/2); however, others could be used. Four fields are provided for the two planforms since each planform would need a beginning (inboard) and ending (outboard) $\bar{y}$-location. The order is for the first planform beginning and ending $\bar{y}$-limits followed by the second planform $\bar{y}$-limits. This card then becomes the last card of the input deck for a configuration.

(3) With the 1. specified in change (1) and SCW specified as 0. the numbers in TBLSCW(I) must be the same on a given planform but can change with planform in order for the program to function properly. This restriction was placed on TBLSCW(I) to save computer execution time.

(4) With the 1. specified in change (1), SCW or TBLSCW(I) must be larger than 1.

### Program Improvements

Improvements to the vortex-lattice computer program presented in reference 6 are detailed below. A listing of the complete revised computer program is presented in appendix B.

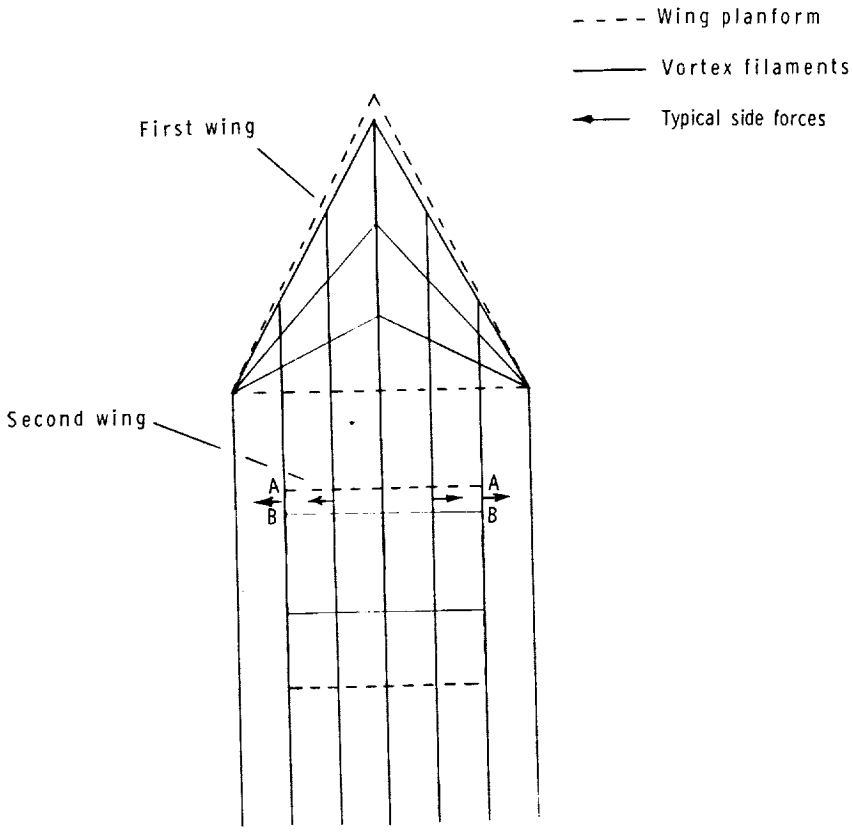
Since the leading-edge thrust and its distribution are obtained by the difference between Lift $\times \alpha$ and induced drag on an overall and local basis, improvements in the accuracy of these terms would yield necessarily more accurate thrust results. Reference 6 has determined ranges of $\overline{N}_C$ and $\overline{N}_S$ required for the convergence of lift for a wide assortment of planforms. A similar study for the near-field induced drag found convergence but not to the far-field values. Reference 10 relates this problem to the

violation of the Munk stagger theorem (ref. 12) in two regards: The induced drag associated with the induced velocity from the bound vortices and from the near-field limit of the trailing vortices should sum to zero, and the bound vortices should be of uniform length.

To implement those ideas, a new overlay was developed (OVERLAY 4) to take the set of $\Gamma/U$ already determined in OVERLAY 2 along with the original vortex lattice in OVERLAY 1 and to repanel the wing with a network of unswept horseshoe vortices of equal spacing whose values of $\Gamma/U$ were determined by interpolation. It is with this setup that the near-field induced drag is now determined.

## OVERLAY 5

The side-force computation is performed in OVERLAY 5 as outlined in the section of this paper entitled "Theoretical Development." Coplanar wings which have an unswept leading edge on the second wing require special attention in the computation of side force and pitching moment at the leading-edge region of the second wing. The side force acting on the trailing vortex filaments of the first wing which intersect the leading edge of the second wing is computed between lines A-A and B-B (shown in sketch (a)) of the second wing.




Sketch (a).

## APPENDIX A

OVERLAY 5 computes $K_{v,le}$ by integrating the local leading-edge suction over the desired portion of the configuration to obtain the total leading-edge suction coefficient $C_S$. This was done to allow the program user the flexibility of choosing the leading-edge region of the wing over which vortex lift is assumed to exist. By making the small angle of attack approximation, which is done throughout the potential flow part of this computer program, $K_{v,le}$ is computed by using the following expression:

$$K_{v,le} = \frac{\partial C_S}{\partial \alpha^2}$$

The values of $K_p$ and $K_{v,le}$ computed by this program in the manner outlined are appropriate only for untwisted or uncambered lifting surfaces. The lift and pitching-moment coefficients are then computed by using the expressions found in reference 4. The side-force computation on planforms with dihedral is performed in a manner similar to that for planforms with no dihedral. For reliable side-edge loading results the program should be restricted to planforms which do not have swept forward leading edges.

## APPENDIX B

## SAMPLE CASE

Input data, the sketch, and output data for a sample case with a canard-body-wing combination are presented in this appendix. The canard shown has 18.6° anhedral, and the leading-edge suction is integrated from the body-wing and body-canard intersections to the respective tips.

The following list contains the output variable names not defined in reference 6:

| | |
|---|---|
| KP | $K_p$ |
| KV LE | $K_{v,le}$ |
| KV SE | $K_{v,se}$ |
| ALPHA | $\alpha$ |
| CN | $C_{N,tot}$ |
| CLP | $C_{L,p}$ |
| CLVLE | $C_{L,vle}$ |
| CLVSE | $K_{v,se} \lvert\sin \alpha\rvert \sin \alpha \cos \alpha$ |
| CMP[2] | pitching-moment coefficient due to $C_{L,p}$ |
| CMVLE[2] | pitching-moment coefficient due to $C_{L,vle}$ |
| CMVSE[2] | pitching-moment coefficient due to $C_{L,vse}$ |
| CM[2] | total pitching moment |
| CD | $C_{L,tot} \tan \alpha$ |
| CL**2/(PI*AR) | $(C_{L,tot})^2/\pi A$ |

[2]Reference point is the origin of the $\bar{X},\bar{Y},\bar{Z}$ axis system.

# APPENDIX B

## Sample Input Data and Sketch

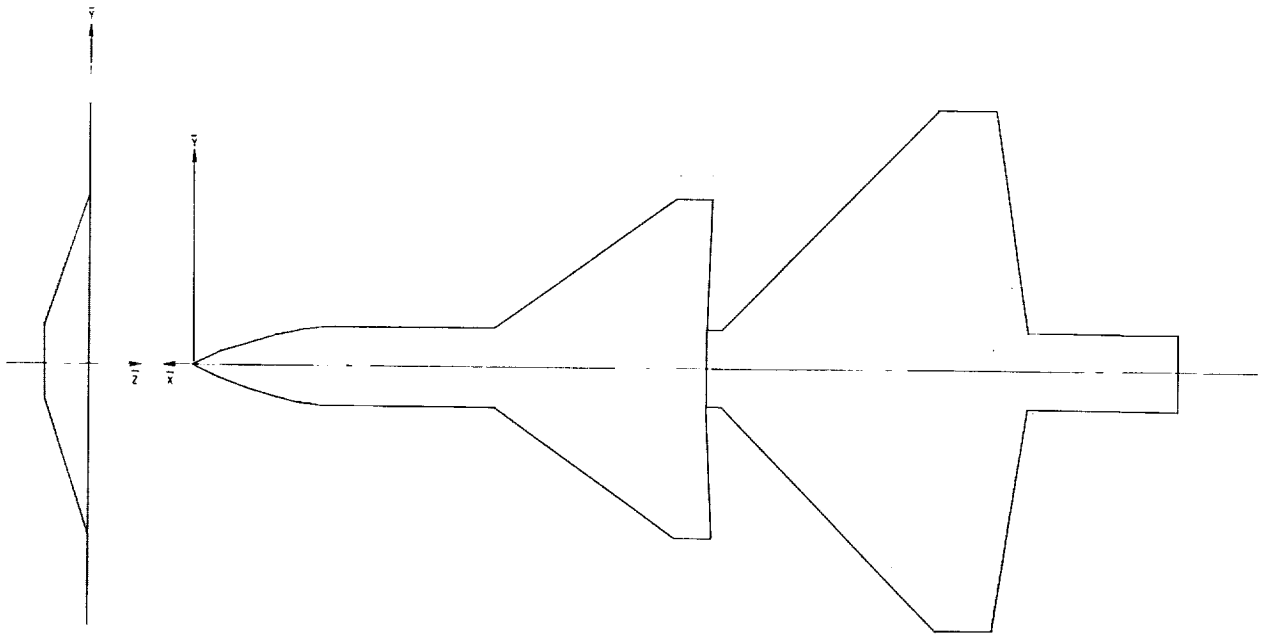
```
                    C O L U M N   N U M B E R S   F O R   I N P U T   D A T A
0000000001111111111222222222233333333334444444444555555555566666666677777777778
1234567890123456789012345678901234567890123456789012345678901234567890123456789
```

GROUP ONE DATA

```
2.          1.          9.1756      159.99696
10.         0.          0.          -1.69
0.0         0.0         0.0         1.
-1.2        -.55        0.          1.
-2.2        -.9         0.          1.
-3.2        -1.2        0.          1.
-4.2        -1.42       0.          1.
-5.         -1.5        0.          1.
-11.65      -1.5        -18.62      1.
-18.60      -6.51       0.          1.
-20.00      -6.51       -18.62      1.
-18.85      -1.5        0.          1.
-18.85      0.0
7.          0.          0.          0.0
-18.85      0.0         0.          1.
-18.85      -1.5        0.          1.
-20.4       -1.5        0.          1.
-28.7       -10.        0.          1.
-30.9       -10.        0.          1.
-32.2       -1.5        0.          1.
-38.        -1.5        0.          1.
-38.        0.0
```

GROUP TWO DATA

```
  1.    6. 13.    .30 1.    0.    0.    0.          0.          1.
-1.5        -15.        -1.5        -15.
```



## Sample Output Data

GEOMETRY DATA

FIRST REFERENCE PLANFORM HAS 10 CURVES

ROOT CHORD HEIGHT = -1.69000 VARIABLE SWEEP PIVOT POSITION X(S) = 0.00000 Y(S) = 0.00000

BREAK POINTS FOR THE REFERENCE PLANFORM

| POINT | X REF | Y REF | SWEEP ANGLE | DIHEDRAL ANGLE | MOVE CODE |
|---|---|---|---|---|---|
| 1 | 0.00000 | 0.00000 | 65.37644 | 0.00000 | 1 |
| 2 | -1.20000 | -.55000 | 70.70995 | 0.00000 | 1 |
| 3 | -2.20000 | -.90000 | 73.30076 | 0.00000 | 1 |
| 4 | -3.20000 | -1.20000 | 77.59258 | 0.00000 | 1 |
| 5 | -4.20000 | -1.42000 | 84.28941 | 0.00000 | 1 |
| 6 | -5.00000 | -1.50000 | 90.00000 | 0.00000 | 1 |
| 7 | -11.65000 | -1.50000 | 54.21355 | -18.62000 | 1 |
| 8 | -18.60000 | -6.51000 | 90.00000 | 0.00000 | 1 |
| 9 | -20.00000 | -6.51000 | 12.92778 | -18.62000 | 1 |
| 10 | -18.85000 | -1.50000 | 0.00000 | 0.00000 | 1 |
| 11 | -18.85000 | 0.00000 | | | |

SECOND REFERENCE PLANFORM HAS 7 CURVES

ROOT CHORD HEIGHT = 0.00000 VARIABLE SWEEP PIVOT POSITION X(S) = 0.00000 Y(S) = 0.00000

BREAK POINTS FOR THE REFERENCE PLANFORM

| POINT | X REF | Y REF | SWEEP ANGLE | DIHEDRAL ANGLE | MOVE CODE |
|---|---|---|---|---|---|
| 1 | -18.85000 | 0.00000 | 0.00000 | 0.00000 | 1 |
| 2 | -18.85000 | -1.50000 | 90.00000 | 0.00000 | 1 |
| 3 | -20.40000 | -1.50000 | 44.31794 | 0.00000 | 1 |
| 4 | -28.70000 | -10.00000 | 90.00000 | 0.00000 | 1 |
| 5 | -30.90000 | -10.00000 | -8.69550 | 0.00000 | 1 |
| 6 | -32.20000 | -1.50000 | 90.00000 | 0.00000 | 1 |
| 7 | -38.00000 | -1.50000 | 0.00000 | 0.00000 | 1 |
| 8 | -38.00000 | 0.00000 | | | |

CONFIGURATION NO. 1

CURVE 1 IS SWEPT 65.37644 DEGREES ON PLANFORM 1

CURVE 1 IS SWEPT 0.00000 DEGREES ON PLANFORM 2

BREAK POINTS FOR THIS CONFIGURATION

| POINT | X | Y | Z | SWEEP ANGLE | DIHEDRAL ANGLE | MOVE CODE |
|---|---|---|---|---|---|---|
| 1 | 0.00000 | 0.00000 | -1.69000 | 65.37644 | 0.00000 | 1 |
| 2 | -1.20000 | -.55000 | -1.69000 | 70.70995 | 0.00000 | 1 |
| 3 | -2.20000 | -.90000 | -1.69000 | 73.30076 | 0.00000 | 1 |
| 4 | -3.20000 | -1.20000 | -1.69000 | 77.59258 | 0.00000 | 1 |
| 5 | -4.20000 | -1.42000 | -1.69000 | 84.28941 | 0.00000 | 1 |
| 6 | -5.00000 | -1.50000 | -1.69000 | 90.00000 | 0.00000 | 1 |
| 7 | -11.65300 | -1.50000 | -1.69000 | 54.21355 | -18.62000 | 1 |
| 8 | -18.60000 | -6.51000 | -.00200 | 90.00000 | 0.00000 | 1 |
| 9 | -20.00000 | -6.51000 | -.00200 | 12.92778 | -18.62000 | 1 |
| 10 | -18.85000 | -1.50000 | -1.69000 | 0.00000 | 0.00000 | 1 |
| 11 | -18.85000 | 0.00000 | -1.69000 | | | |

SECOND PLANFORM BREAK POINTS

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | -18.85000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 1 |
| 2 | -18.85000 | -.55000 | 0.00000 | 0.00000 | 0.00000 | 1 |
| 3 | -18.85000 | -.90000 | 0.00000 | 0.00000 | 0.00000 | 1 |
| 4 | -18.85000 | -1.20000 | 0.00000 | 0.00000 | 0.00000 | 1 |
| 5 | -18.85000 | -1.42000 | 0.00000 | 0.00000 | 0.00000 | 1 |
| 6 | -18.85000 | -1.50000 | 0.00000 | 90.00000 | 0.00000 | 1 |
| 7 | -20.40000 | -1.50000 | 0.00000 | 44.31794 | 0.00000 | 1 |
| 8 | -25.29212 | -6.51000 | 0.00000 | 44.31794 | 0.00000 | 1 |
| 9 | -28.70000 | -10.00000 | 0.00000 | 90.00000 | 0.00000 | 1 |
| 10 | -30.90000 | -10.00000 | 0.00000 | -8.69550 | 0.00000 | 1 |
| 11 | -32.20000 | -1.50000 | 0.00000 | 90.00000 | 0.00000 | 1 |
| 12 | -38.00000 | -1.50000 | 0.00000 | 0.00000 | 0.00000 | 1 |
| 13 | -38.00000 | 0.00000 | 0.00000 | | | |

174 HORSESHOE VORTICES USED ON THE LEFT HALF OF THE CONFIGURATION

| PLANFORM | TOTAL | SPANWISE |
|---|---|---|

AERODYNAMIC DATA

CONFIGURATION NO. 1

STATIC LONGITUDINAL AERODYNAMIC COEFFICIENTS ARE COMPUTED

| X C/4 | X 3C/4 | Y | Z | S | C/4 SWEEP ANGLE | DIHEDRAL ANGLE | LOCAL ALPHA IN RADIANS | DELTA CP AT DESIRED CL = 1.00000 |
|---|---|---|---|---|---|---|---|---|
| -18.17029 | -18.32212 | -6.14552 | -.12481 | .38462 | 53.24644 | -18.62000 | 0.00000 | 3.72658 |
| -18.47395 | -18.62578 | -6.14552 | -.12481 | .38462 | 48.89306 | -18.62000 | 0.00000 | 1.69346 |
| -18.77761 | -18.92944 | -6.14552 | -.12481 | .38462 | 43.62423 | -18.62000 | 0.00000 | 1.04381 |
| -19.08127 | -19.23310 | -6.14552 | -.12481 | .38462 | 37.24015 | -18.62000 | 0.00000 | .66053 |
| -19.38493 | -19.53676 | -6.14552 | -.12481 | .38462 | 29.56186 | -18.62000 | 0.00000 | .41117 |
| -19.68859 | -19.84042 | -6.14552 | -.12481 | .38462 | 20.51844 | -18.62000 | 0.00000 | .22533 |
| -17.19422 | -17.41637 | -5.41655 | -.37041 | .38462 | 53.24644 | -18.62000 | 0.00000 | 3.41634 |
| -17.63853 | -17.86068 | -5.41655 | -.37041 | .38462 | 48.89306 | -18.62000 | 0.00000 | 1.60920 |
| -18.08284 | -18.30500 | -5.41655 | -.37041 | .38462 | 43.62423 | -18.62000 | 0.00000 | 1.06980 |
| -18.52715 | -18.74931 | -5.41655 | -.37041 | .38462 | 37.24015 | -18.62000 | 0.00000 | .74750 |
| -18.97146 | -19.19362 | -5.41655 | -.37041 | .38462 | 29.56186 | -18.62000 | 0.00000 | .50397 |
| -19.41577 | -19.63793 | -5.41655 | -.37041 | .38462 | 20.51844 | -18.62000 | 0.00000 | .29033 |
| -16.21814 | -16.51062 | -4.68758 | -.61602 | .38462 | 53.24644 | -18.62000 | 0.00000 | 3.06694 |
| -16.80310 | -17.09558 | -4.68758 | -.61602 | .38462 | 48.89306 | -18.62000 | 0.00000 | 1.45406 |
| -17.38807 | -17.68055 | -4.68758 | -.61602 | .38462 | 43.62423 | -18.62000 | 0.00000 | .99044 |
| -17.97303 | -18.26551 | -4.68758 | -.61602 | .38462 | 37.24015 | -18.62000 | 0.00000 | .71586 |
| -18.55799 | -18.85048 | -4.68758 | -.61602 | .38462 | 29.56186 | -18.62000 | 0.00000 | .50163 |
| -19.14296 | -19.43544 | -4.68758 | -.61602 | .38462 | 20.51844 | -18.62000 | 0.00000 | .29981 |
| -15.24206 | -15.60487 | -3.95862 | -.86163 | .38462 | 53.24644 | -18.62000 | 0.00000 | 2.75671 |
| -15.96768 | -16.33048 | -3.95862 | -.86163 | .38462 | 48.89306 | -18.62000 | 0.00000 | 1.31328 |
| -16.69329 | -17.05610 | -3.95862 | -.86163 | .38462 | 43.62423 | -18.62000 | 0.00000 | .90859 |
| -17.41891 | -17.78172 | -3.95862 | -.86163 | .38462 | 37.24015 | -18.62000 | 0.00000 | .66947 |
| -18.14452 | -18.50733 | -3.95862 | -.86163 | .38462 | 29.56186 | -18.62000 | 0.00000 | .47964 |
| -18.87014 | -19.23295 | -3.95862 | -.86163 | .38462 | 20.51844 | -18.62000 | 0.00000 | .29326 |
| -14.26598 | -14.69911 | -3.22965 | -1.10724 | .38462 | 53.24644 | -18.62000 | 0.00000 | 2.48005 |
| -15.13225 | -15.56538 | -3.22965 | -1.10724 | .38462 | 48.89306 | -18.62000 | 0.00000 | 1.18951 |
| -15.99852 | -16.43165 | -3.22965 | -1.10724 | .38462 | 43.62423 | -18.62000 | 0.00000 | .83349 |
| -16.86479 | -17.29792 | -3.22965 | -1.10724 | .38462 | 37.24015 | -18.62000 | 0.00000 | .62596 |
| -17.73105 | -18.16419 | -3.22965 | -1.10724 | .38462 | 29.56186 | -18.62000 | 0.00000 | .45656 |
| -18.59732 | -19.03046 | -3.22965 | -1.10724 | .38462 | 20.51844 | -18.62000 | 0.00000 | .28069 |
| -13.28990 | -13.79336 | -2.50068 | -1.35284 | .38462 | 53.24644 | -18.62000 | 0.00000 | 2.22473 |
| -14.29682 | -14.80028 | -2.50068 | -1.35284 | .38462 | 48.89306 | -18.62000 | 0.00000 | 1.08091 |
| -15.30374 | -15.80720 | -2.50068 | -1.35284 | .38462 | 43.62423 | -18.62000 | 0.00000 | .76725 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| -16.31066 | -16.81413 | -2.50068 | -1.35284 | .38462 | 37.24015 | -18.62000 | 0.00000 | .58092 |
| -17.31759 | -17.82105 | -2.50068 | -1.35284 | .38462 | 29.56186 | -18.62000 | 0.00000 | .44657 |
| -18.32451 | -18.82797 | -2.50068 | -1.35284 | .38462 | 20.51844 | -18.62000 | 0.00000 | .26158 |
| -12.37593 | -12.94524 | -1.81810 | -1.58282 | .33567 | 53.24644 | -18.62000 | 0.00000 | 2.05972 |
| -13.51455 | -14.08387 | -1.81810 | -1.58282 | .33567 | 48.89306 | -18.62000 | 0.00000 | .87773 |
| -14.65318 | -15.22249 | -1.81810 | -1.58282 | .33567 | 43.62423 | -18.62000 | 0.00000 | .80396 |
| -15.79180 | -16.36111 | -1.81810 | -1.58282 | .33567 | 37.24015 | -18.62000 | 0.00000 | .46991 |
| -16.93043 | -17.49974 | -1.81810 | -1.58282 | .33567 | 29.56186 | -18.62000 | 0.00000 | .49827 |
| -18.06905 | -18.63836 | -1.81810 | -1.58282 | .33567 | 20.51844 | -18.62000 | 0.00000 | .22120 |
| -5.19375 | -6.38125 | -1.46000 | -1.69000 | .04000 | 84.04287 | 0.00000 | 0.00000 | .26730 |
| -7.56875 | -8.75625 | -1.46000 | -1.69000 | .04000 | 82.80077 | 0.00000 | 0.00000 | .03916 |
| -9.94375 | -11.13125 | -1.46000 | -1.69000 | .04000 | 80.90972 | 0.00000 | 0.00000 | .05710 |
| -12.31875 | -13.50625 | -1.46000 | -1.69000 | .04000 | 77.69198 | 0.00000 | 0.00000 | 1.05621 |
| -14.69375 | -15.88125 | -1.46000 | -1.69000 | .04000 | 71.07536 | 0.00000 | 0.00000 | .69435 |
| -17.06875 | -18.25625 | -1.46000 | -1.69000 | .04000 | 51.34019 | 0.00000 | 0.00000 | .40845 |
| -4.33125 | -5.59375 | -1.31000 | -1.69000 | .11000 | 77.07090 | 0.00000 | 0.00000 | .40797 |
| -6.85625 | -8.11875 | -1.31000 | -1.69000 | .11000 | 74.46967 | 0.00000 | 0.00000 | .06902 |
| -9.38125 | -10.64375 | -1.31000 | -1.69000 | .11000 | 70.60793 | 0.00000 | 0.00000 | .08068 |
| -11.90625 | -13.16875 | -1.31000 | -1.69000 | .11000 | 64.35899 | 0.00000 | 0.00000 | .72423 |
| -14.43125 | -15.69375 | -1.31000 | -1.69000 | .11000 | 52.97327 | 0.00000 | 0.00000 | .69555 |
| -16.95625 | -18.21875 | -1.31000 | -1.69000 | .11000 | 29.60445 | 0.00000 | 0.00000 | .41693 |
| -3.37292 | -4.71875 | -1.05000 | -1.69000 | .15000 | 72.61761 | 0.00000 | 0.00000 | .48129 |
| -6.06458 | -7.41042 | -1.05000 | -1.69000 | .15000 | 69.24593 | 0.00000 | 0.00000 | .10972 |
| -8.75625 | -10.10208 | -1.05000 | -1.69000 | .15000 | 64.35899 | 0.00000 | 0.00000 | .09115 |
| -11.44792 | -12.79375 | -1.05000 | -1.69000 | .15000 | 56.79343 | 0.00000 | 0.00000 | .52299 |
| -14.13958 | -15.48542 | -1.05000 | -1.69000 | .15000 | 44.19307 | 0.00000 | 0.00000 | .65413 |
| -16.83125 | -18.17708 | -1.05000 | -1.69000 | .15000 | 22.61987 | 0.00000 | 0.00000 | .41141 |
| -2.41458 | -3.84375 | -.72500 | -1.69000 | .17500 | 69.93693 | 0.00000 | 0.00000 | .50002 |
| -5.27292 | -6.70208 | -.72500 | -1.69000 | .17500 | 66.14953 | 0.00000 | 0.00000 | .14697 |
| -8.13125 | -9.56042 | -.72500 | -1.69000 | .17500 | 60.75117 | 0.00000 | 0.00000 | .09444 |
| -10.98958 | -12.41875 | -.72500 | -1.69000 | .17500 | 52.63333 | 0.00000 | 0.00000 | .40121 |
| -13.84792 | -15.27708 | -.72500 | -1.69000 | .17500 | 39.80557 | 0.00000 | 0.00000 | .61283 |
| -16.70625 | -18.13542 | -.72500 | -1.69000 | .17500 | 19.65382 | 0.00000 | 0.00000 | .40307 |
| -1.36042 | -2.88125 | -.27500 | -1.69000 | .27500 | 64.44004 | 0.00000 | 0.00000 | .48819 |
| -4.40208 | -5.92292 | -.27500 | -1.69000 | .27500 | 59.93142 | 0.00000 | 0.00000 | .17141 |
| -7.44375 | -8.96458 | -.27500 | -1.69000 | .27500 | 53.74616 | 0.00000 | 0.00000 | .09460 |
| -10.48542 | -12.00625 | -.27500 | -1.69000 | .27500 | 45.00000 | 0.00000 | 0.00000 | .32584 |
| -13.52708 | -15.04792 | -.27500 | -1.69000 | .27500 | 32.47119 | 0.00000 | 0.00000 | .56958 |
| -16.56875 | -18.08958 | -.27500 | -1.69000 | .27500 | 15.25512 | 0.00000 | 0.00000 | .39267 |

SECOND PLANFORM HORSESHOE VORTEX DESCRIPTIONS

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| -28.43420 | -28.65373 | -9.61538 | 0.00000 | .38462 | 42.90475 | 0.00000 | 0.00000 | 4.03015 |
| -28.87327 | -29.09280 | -9.61538 | 0.00000 | .38462 | 36.54497 | 0.00000 | 0.00000 | 1.54306 |
| -29.31233 | -29.53186 | -9.61538 | 0.00000 | .38462 | 28.94001 | 0.00000 | 0.00000 | .79538 |
| -29.75140 | -29.97093 | -9.61538 | 0.00000 | .38462 | 20.03721 | 0.00000 | 0.00000 | .45779 |
| -30.19046 | -30.40999 | -9.61538 | 0.00000 | .38462 | 10.00798 | 0.00000 | 0.00000 | .27680 |
| -30.62952 | -30.84906 | -9.61538 | 0.00000 | .38462 | -.67404 | 0.00000 | 0.00000 | .15319 |
| -27.71927 | -28.01120 | -8.84615 | 0.00000 | .38462 | 42.90475 | 0.00000 | 0.00000 | 4.06426 |
| -28.30313 | -28.59506 | -8.84615 | 0.00000 | .38462 | 36.54497 | 0.00000 | 0.00000 | 1.72615 |
| -28.88699 | -29.17892 | -8.84615 | 0.00000 | .38462 | 28.94001 | 0.00000 | 0.00000 | 1.01160 |

# APPENDIX B

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| -29.47085 | -29.76278 | -8.84615 | 0.00000 | .38462 | 20.03721 | 0.00000 | 0.00000 | .62038 |
| -30.05471 | -30.34664 | -8.84615 | 0.00000 | .38462 | 10.00798 | 0.00000 | 0.00000 | .37816 |
| -30.63857 | -30.93051 | -8.84615 | 0.00000 | .38462 | -.67404 | 0.00000 | 0.00000 | .20487 |
| -27.00434 | -27.36867 | -8.07692 | 0.00000 | .38462 | 42.90475 | 0.00000 | 0.00000 | 3.90372 |
| -27.73299 | -28.09732 | -8.07692 | 0.00000 | .38462 | 36.54497 | 0.00000 | 0.00000 | 1.67207 |
| -28.46165 | -28.82598 | -8.07692 | 0.00000 | .38462 | 28.94001 | 0.00000 | 0.00000 | 1.01718 |
| -29.19031 | -29.55464 | -8.07692 | 0.00000 | .38462 | 20.03721 | 0.00000 | 0.00000 | .64912 |
| -29.91897 | -30.28330 | -8.07692 | 0.00000 | .38462 | 10.00798 | 0.00000 | 0.00000 | .40451 |
| -30.64762 | -31.01195 | -8.07692 | 0.00000 | .38462 | -.67404 | 0.00000 | 0.00000 | .21969 |
| -26.28940 | -26.72613 | -7.30769 | 0.00000 | .38462 | 42.90475 | 0.00000 | 0.00000 | 3.75602 |
| -27.16286 | -27.59959 | -7.30769 | 0.00000 | .38462 | 36.54497 | 0.00000 | 0.00000 | 1.55480 |
| -28.03631 | -28.47304 | -7.30769 | 0.00000 | .38462 | 28.94001 | 0.00000 | 0.00000 | .95388 |
| -28.90977 | -29.34649 | -7.30769 | 0.00000 | .38462 | 20.03721 | 0.00000 | 0.00000 | .62259 |
| -29.78322 | -30.21995 | -7.30769 | 0.00000 | .38462 | 10.00798 | 0.00000 | 0.00000 | .39546 |
| -30.65667 | -31.09340 | -7.30769 | 0.00000 | .38462 | -.67404 | 0.00000 | 0.00000 | .21653 |
| -25.73998 | -26.23234 | -6.71654 | 0.00000 | .20654 | 42.90475 | 0.00000 | 0.00000 | 3.75572 |
| -26.72471 | -27.21707 | -6.71654 | 0.00000 | .20654 | 36.54497 | 0.00000 | 0.00000 | 1.38093 |
| -27.70944 | -28.20180 | -6.71654 | 0.00000 | .20654 | 28.94001 | 0.00000 | 0.00000 | .87260 |
| -28.69417 | -29.18653 | -6.71654 | 0.00000 | .20654 | 20.03721 | 0.00000 | 0.00000 | .58406 |
| -29.67890 | -30.17126 | -6.71654 | 0.00000 | .20654 | 10.00798 | 0.00000 | 0.00000 | .37780 |
| -30.66363 | -31.15599 | -6.71654 | 0.00000 | .20654 | -.67404 | 0.00000 | 0.00000 | .20889 |
| -25.19055 | -25.73856 | -6.12538 | 0.00000 | .38462 | 42.90475 | 0.00000 | 0.00000 | 1.55688 |
| -26.28656 | -26.83456 | -6.12538 | 0.00000 | .38462 | 36.54497 | 0.00000 | 0.00000 | 1.12328 |
| -27.38257 | -27.93057 | -6.12538 | 0.00000 | .38462 | 28.94001 | 0.00000 | 0.00000 | .78078 |
| -28.47857 | -29.02657 | -6.12538 | 0.00000 | .38462 | 20.03721 | 0.00000 | 0.00000 | .54240 |
| -29.57458 | -30.12258 | -6.12538 | 0.00000 | .38462 | 10.00798 | 0.00000 | 0.00000 | .35835 |
| -30.67058 | -31.21859 | -6.12538 | 0.00000 | .38462 | -.67404 | 0.00000 | 0.00000 | .20024 |
| -24.47562 | -25.09602 | -5.35615 | 0.00000 | .38462 | 42.90475 | 0.00000 | 0.00000 | 1.20203 |
| -25.71642 | -26.33683 | -5.35615 | 0.00000 | .38462 | 36.54497 | 0.00000 | 0.00000 | .80400 |
| -26.95723 | -27.57763 | -5.35615 | 0.00000 | .38462 | 28.94001 | 0.00000 | 0.00000 | .64956 |
| -28.19803 | -28.81843 | -5.35615 | 0.00000 | .38462 | 20.03721 | 0.00000 | 0.00000 | .48163 |
| -29.43883 | -30.05923 | -5.35615 | 0.00000 | .38462 | 10.00798 | 0.00000 | 0.00000 | .32869 |
| -30.67963 | -31.30003 | -5.35615 | 0.00000 | .38462 | -.67404 | 0.00000 | 0.00000 | .18653 |
| -23.76069 | -24.45349 | -4.58692 | 0.00000 | .38462 | 42.90475 | 0.00000 | 0.00000 | 1.07099 |
| -25.14629 | -25.83909 | -4.58692 | 0.00000 | .38462 | 36.54497 | 0.00000 | 0.00000 | .64833 |
| -26.53189 | -27.22469 | -4.58692 | 0.00000 | .38462 | 28.94001 | 0.00000 | 0.00000 | .54302 |
| -27.91749 | -28.61029 | -4.58692 | 0.00000 | .38462 | 20.03721 | 0.00000 | 0.00000 | .42692 |
| -29.30308 | -29.99588 | -4.58692 | 0.00000 | .38462 | 10.00798 | 0.00000 | 0.00000 | .30159 |
| -30.68868 | -31.38148 | -4.58692 | 0.00000 | .38462 | -.67404 | 0.00000 | 0.00000 | .17359 |
| -23.04576 | -23.81095 | -3.81769 | 0.00000 | .38462 | 42.90475 | 0.00000 | 0.00000 | .97541 |
| -24.57615 | -25.34135 | -3.81769 | 0.00000 | .38462 | 36.54497 | 0.00000 | 0.00000 | .56518 |
| -26.10655 | -26.87175 | -3.81769 | 0.00000 | .38462 | 28.94001 | 0.00000 | 0.00000 | .47066 |
| -27.63694 | -28.40214 | -3.81769 | 0.00000 | .38462 | 20.03721 | 0.00000 | 0.00000 | .38345 |
| -29.16734 | -29.93254 | -3.81769 | 0.00000 | .38462 | 10.00798 | 0.00000 | 0.00000 | .27953 |
| -30.69773 | -31.46293 | -3.81769 | 0.00000 | .38462 | -.67404 | 0.00000 | 0.00000 | .16170 |
| -22.33083 | -23.16842 | -3.04846 | 0.00000 | .38462 | 42.90475 | 0.00000 | 0.00000 | .88966 |
| -24.00602 | -24.84361 | -3.04846 | 0.00000 | .38462 | 36.54497 | 0.00000 | 0.00000 | .51438 |
| -25.68121 | -26.51880 | -3.04846 | 0.00000 | .38462 | 28.94001 | 0.00000 | 0.00000 | .42166 |
| -27.35640 | -28.19400 | -3.04846 | 0.00000 | .38462 | 20.03721 | 0.00000 | 0.00000 | .35200 |
| -29.03159 | -29.86919 | -3.04846 | 0.00000 | .38462 | 10.00798 | 0.00000 | 0.00000 | .26443 |
| -30.70678 | -31.54438 | -3.04846 | 0.00000 | .38462 | -.67404 | 0.00000 | 0.00000 | .14966 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| -21.61589 | -22.52589 | -2.27923 | 0.00000 | .38462 | 42.90475 | 0.00000 | 0.00000 | .80015 |
| -23.43588 | -24.34587 | -2.27923 | 0.00000 | .38462 | 36.54497 | 0.00000 | 0.00000 | .49118 |
| -25.25587 | -26.16586 | -2.27923 | 0.00000 | .38462 | 28.94001 | 0.00000 | 0.00000 | .37956 |
| -27.07586 | -27.98585 | -2.27923 | 0.00000 | .38462 | 20.03721 | 0.00000 | 0.00000 | .33268 |
| -28.89584 | -29.80584 | -2.27923 | 0.00000 | .38462 | 10.00798 | 0.00000 | 0.00000 | .25925 |
| -30.71583 | -31.62583 | -2.27923 | 0.00000 | .38462 | -.67404 | 0.00000 | 0.00000 | .13259 |
| -21.07505 | -22.03981 | -1.69731 | 0.00000 | .19731 | 42.90475 | 0.00000 | 0.00000 | .71316 |
| -23.00457 | -23.96934 | -1.69731 | 0.00000 | .19731 | 36.54497 | 0.00000 | 0.00000 | .52206 |
| -24.93410 | -25.89886 | -1.69731 | 0.00000 | .19731 | 28.94001 | 0.00000 | 0.00000 | .30040 |
| -26.86363 | -27.82839 | -1.69731 | 0.00000 | .19731 | 20.03721 | 0.00000 | 0.00000 | .35297 |
| -28.79315 | -29.75792 | -1.69731 | 0.00000 | .19731 | 10.00798 | 0.00000 | 0.00000 | .27534 |
| -30.72268 | -31.68744 | -1.69731 | 0.00000 | .19731 | -.67404 | 0.00000 | 0.00000 | .09532 |
| -19.64792 | -21.24375 | -1.46000 | 0.00000 | .04000 | 0.00000 | 0.00000 | 0.00000 | .39401 |
| -22.83958 | -24.43542 | -1.46000 | 0.00000 | .04000 | 0.00000 | 0.00000 | 0.00000 | .37683 |
| -26.03125 | -27.62708 | -1.46000 | 0.00000 | .04000 | 0.00000 | 0.00000 | 0.00000 | .36901 |
| -29.22292 | -30.81875 | -1.46000 | 0.00000 | .04000 | 0.00000 | 0.00000 | 0.00000 | .21472 |
| -32.41458 | -34.01042 | -1.46000 | 0.00000 | .04000 | 0.00000 | 0.00000 | 0.00000 | .03357 |
| -35.60625 | -37.20208 | -1.46000 | 0.00000 | .04000 | 0.00000 | 0.00000 | 0.00000 | .00860 |
| -19.64792 | -21.24375 | -1.31000 | 0.00000 | .11000 | 0.00000 | 0.00000 | 0.00000 | .38667 |
| -22.83958 | -24.43542 | -1.31000 | 0.00000 | .11000 | 0.00000 | 0.00000 | 0.00000 | .40078 |
| -26.03125 | -27.62708 | -1.31000 | 0.00000 | .11000 | 0.00000 | 0.00000 | 0.00000 | .35211 |
| -29.22292 | -30.81875 | -1.31000 | 0.00000 | .11000 | 0.00000 | 0.00000 | 0.00000 | .21240 |
| -32.41458 | -34.01042 | -1.31000 | 0.00000 | .11000 | 0.00000 | 0.00000 | 0.00000 | .05136 |
| -35.60625 | -37.20208 | -1.31000 | 0.00000 | .11000 | 0.00000 | 0.00000 | 0.00000 | .01443 |
| -19.64792 | -21.24375 | -1.05000 | 0.00000 | .15000 | 0.00000 | 0.00000 | 0.00000 | .40181 |
| -22.83958 | -24.43542 | -1.05000 | 0.00000 | .15000 | 0.00000 | 0.00000 | 0.00000 | .40029 |
| -26.03125 | -27.62708 | -1.05000 | 0.00000 | .15000 | 0.00000 | 0.00000 | 0.00000 | .33914 |
| -29.22292 | -30.81875 | -1.05000 | 0.00000 | .15000 | 0.00000 | 0.00000 | 0.00000 | .21200 |
| -32.41458 | -34.01042 | -1.05000 | 0.00000 | .15000 | 0.00000 | 0.00000 | 0.00000 | .06333 |
| -35.60625 | -37.20208 | -1.05000 | 0.00000 | .15000 | 0.00000 | 0.00000 | 0.00000 | .01950 |
| -19.64792 | -21.24375 | -.72500 | 0.00000 | .17500 | 0.00000 | 0.00000 | 0.00000 | .42072 |
| -22.83958 | -24.43542 | -.72500 | 0.00000 | .17500 | 0.00000 | 0.00000 | 0.00000 | .39237 |
| -26.03125 | -27.62708 | -.72500 | 0.00000 | .17500 | 0.00000 | 0.00000 | 0.00000 | .33066 |
| -29.22292 | -30.81875 | -.72500 | 0.00000 | .17500 | 0.00000 | 0.00000 | 0.00000 | .21129 |
| -32.41458 | -34.01042 | -.72500 | 0.00000 | .17500 | 0.00000 | 0.00000 | 0.00000 | .07126 |
| -35.60625 | -37.20208 | -.72500 | 0.00000 | .17500 | 0.00000 | 0.00000 | 0.00000 | .02322 |
| -19.64792 | -21.24375 | -.27500 | 0.00000 | .27500 | 0.00000 | 0.00000 | 0.00000 | .43575 |
| -22.83958 | -24.43542 | -.27500 | 0.00000 | .27500 | 0.00000 | 0.00000 | 0.00000 | .38501 |
| -26.03125 | -27.62708 | -.27500 | 0.00000 | .27500 | 0.00000 | 0.00000 | 0.00000 | .32522 |
| -29.22292 | -30.81875 | -.27500 | 0.00000 | .27500 | 0.00000 | 0.00000 | 0.00000 | .21049 |
| -32.41458 | -34.01042 | -.27500 | 0.00000 | .27500 | 0.00000 | 0.00000 | 0.00000 | .07638 |
| -35.60625 | -37.20208 | -.27500 | 0.00000 | .27500 | 0.00000 | 0.00000 | 0.00000 | .02574 |

| REF. CHORD | C AVERAGE | TRUE AREA | REFERENCE AREA | B/2 | REF. AR | TRUE AR | MACH NUMBER |
|---|---|---|---|---|---|---|---|
| 9.17560 | 13.51260 | 270.25200 | 159.99696 | 10.00000 | 2.50005 | 1.48010 | .30000 |

COMPLETE CONFIGURATION

| DESIRED CL | COMPUTED ALPHA |
|---|---|
| 1.00000 | 17.90535 |

WING-BODY CHARACTERISTICS

| LIFT | INDUCED DRAG (FAR FIELD SOLUTION) | |
|---|---|---|
| CL(WB) | CDI AT CL(WB) | CDI/(CL(WB)**2) (1/(PI*AR) = .12732 ) |
| .59724 | .06733 | .18876 |

COMPLETE CONFIGURATION CHARACTERISTICS

| CL ALPHA PER RADIAN | CL ALPHA PER DEGREE | CL(TWIST) | ALPHA AT CL=0 | Y CP | CM/CL | CMO |
|---|---|---|---|---|---|---|
| 3.19992 | .05585 | 0.00000 | -0.00000 | -.41849 | -2.33969 | 0.00000 |

ADDITIONAL LOADING WITH CL BASED ON S(TRUE)

| STATION | 2Y/B | SL COEF | CL RATIO | C RATIO | LOAD DUE TO TWIST | ADD. LOAD AT CL= 0.00000 | BASIC LOAD AT CL=0 | SPAN LOAD AT DESIRED CL | -AT CL DES- X LOCATON OF LOCAL CENT PR |
|---|---|---|---|---|---|---|---|---|---|
| 1 | -.61455 | .29459 | 2.18482 | .13483 | 0.00000 | 0.00000 | 0.00000 | .17440 | -18.50420 |
| 2 | -.54165 | .42417 | 2.14999 | .19729 | 0.00000 | 0.00000 | 0.00000 | .25112 | -17.74451 |
| 3 | -.46876 | .51395 | 1.97871 | .25974 | 0.00000 | 0.00000 | 0.00000 | .30428 | -16.97449 |
| 4 | -.39586 | .58240 | 1.80761 | .32220 | 0.00000 | 0.00000 | 0.00000 | .34480 | -16.20531 |
| 5 | -.32296 | .63523 | 1.65146 | .38465 | 0.00000 | 0.00000 | 0.00000 | .37608 | -15.44203 |
| 6 | -.25007 | .67490 | 1.50949 | .44710 | 0.00000 | 0.00000 | 0.00000 | .39956 | -14.68937 |
| 7 | -.18181 | .70180 | 1.38810 | .50558 | 0.00000 | 0.00000 | 0.00000 | .41549 | -13.99110 |
| 8 | -.14600 | .74890 | .71015 | 1.05457 | 0.00000 | 0.00000 | 0.00000 | .44337 | -12.85910 |
| 9 | -.13100 | .75574 | .67406 | 1.12118 | 0.00000 | 0.00000 | 0.00000 | .44742 | -11.99776 |
| 10 | -.10500 | .76401 | .63924 | 1.19518 | 0.00000 | 0.00000 | 0.00000 | .45231 | -11.11893 |
| 11 | -.07250 | .77124 | .60767 | 1.26919 | 0.00000 | 0.00000 | 0.00000 | .45660 | -10.36793 |
| 12 | -.02750 | .77651 | .57494 | 1.35059 | 0.00000 | 0.00000 | 0.00000 | .45972 | -9.67063 |
| | | | | CONTRIBUTION OF THE SECOND PLANFORM TO SPAN LOAD DISTRIBUTION | | | | | |
| 13 | -.96154 | .39826 | 2.04280 | .19496 | 0.00000 | 0.00000 | 0.00000 | .23578 | -28.82026 |
| 14 | -.88462 | .58427 | 2.25367 | .25925 | 0.00000 | 0.00000 | 0.00000 | .34590 | -28.31349 |
| 15 | -.80769 | .71649 | 2.21450 | .32355 | 0.00000 | 0.00000 | 0.00000 | .42418 | -27.77968 |
| 16 | -.73077 | .81880 | 2.11118 | .38784 | 0.00000 | 0.00000 | 0.00000 | .48475 | -27.22058 |
| 17 | -.67165 | .88381 | 2.02130 | .43725 | 0.00000 | 0.00000 | 0.00000 | .52324 | -26.75954 |
| 18 | -.61254 | .62500 | 1.28426 | .48666 | 0.00000 | 0.00000 | 0.00000 | .37002 | -26.81144 |
| 19 | -.53362 | .56651 | 1.02823 | .55095 | 0.00000 | 0.00000 | 0.00000 | .33539 | -26.44443 |
| 20 | -.45469 | .54809 | .89085 | .61525 | 0.00000 | 0.00000 | 0.00000 | .32449 | -25.98917 |
| 21 | -.38177 | .54252 | .79836 | .67954 | 0.00000 | 0.00000 | 0.00000 | .32119 | -25.51920 |
| 22 | -.30485 | .54273 | .72963 | .74384 | 0.00000 | 0.00000 | 0.00000 | .32131 | -25.05822 |
| 23 | -.22792 | .54496 | .67435 | .80813 | 0.00000 | 0.00000 | 0.00000 | .32263 | -24.61574 |
| 24 | -.16973 | .54492 | .63602 | .85677 | 0.00000 | 0.00000 | 0.00000 | .32261 | -24.28605 |
| 25 | -.14600 | .55725 | .39321 | 1.41720 | 0.00000 | 0.00000 | 0.00000 | .32991 | -24.07250 |
| 26 | -.13100 | .56563 | .39912 | 1.41720 | 0.00000 | 0.00000 | 0.00000 | .33487 | -24.19489 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 27 | -.10500 | .57294 | .40428 | 1.41720 | 0.00000 | 0.00000 | 0.00000 | .33920 | -24.23822 |
| 28 | -.07250 | .57830 | .40806 | 1.41720 | 0.00000 | 0.00000 | 0.00000 | .34237 | -24.24694 |
| 29 | -.02750 | .58193 | .41062 | 1.41720 | 0.00000 | 0.00000 | 0.00000 | .34452 | -24.24557 |

INDUCED DRAG, LEADING EDGE THRUST AND SUCTION COEFFICIENT CHARACTERISTICS
COMPUTED AT THE DESIRED CL FROM A NEAR FIELD SOLUTION

SECTION COEFFICIENTS

| STATION | 2Y/B | L. E. SWEEP ANGLE | CDII C/2B | CT C/2B | CS C/2B |
|---|---|---|---|---|---|
| 1 | -.61455 | 54.21355 | -.00351 | .02261 | .03866 |
| 2 | -.54165 | 54.21355 | -.00450 | .03094 | .05292 |
| 3 | -.46876 | 54.21355 | -.00070 | .03272 | .05595 |
| 4 | -.39586 | 54.21355 | .00393 | .03234 | .05530 |
| 5 | -.32296 | 54.21355 | .00881 | .03082 | .05271 |
| 6 | -.25007 | 54.21355 | .01540 | .02672 | .04569 |
| 7 | -.18181 | 54.21355 | .02575 | .01890 | .10663 |
| 8 | -.14600 | 84.28941 | .02279 | .02402 | .23456 |
| 9 | -.13100 | 77.59258 | .02687 | .02025 | .18165 |
| 10 | -.10500 | 73.30076 | .03394 | .01370 | .08992 |
| 11 | -.07250 | 70.70995 | .04300 | .00512 | .01812 |
| 12 | -.02750 | 65.37644 | .05588 | -.00735 | -.01808 |

CONTRIBUTION OF THE SECOND PLANFORM TO THE CHORD OR DRAG FORCE

| | | | | | |
|---|---|---|---|---|---|
| 13 | -.96154 | 44.31794 | -.01214 | .03563 | .04979 |
| 14 | -.88462 | 44.31794 | -.00759 | .04391 | .06137 |
| 15 | -.80769 | 44.31794 | -.00567 | .05030 | .07031 |
| 16 | -.73077 | 44.31794 | .00017 | .05097 | .07123 |
| 17 | -.67165 | 44.31794 | .03605 | .01768 | .02471 |
| 18 | -.61254 | 44.31794 | .06006 | -.01999 | -.02793 |
| 19 | -.53562 | 44.31794 | .03478 | .00107 | .00149 |
| 20 | -.45869 | 44.31794 | .02943 | .00496 | .00693 |
| 21 | -.38177 | 44.31794 | .02890 | .00501 | .00700 |
| 22 | -.30485 | 44.31794 | .02974 | .00420 | .00587 |
| 23 | -.22792 | 44.31794 | .03063 | .00341 | .00476 |
| 24 | -.16973 | 44.31794 | .03376 | .00075 | .00124 |
| 25 | -.14600 | 0.00000 | .03551 | -.00070 | -.00070 |
| 26 | -.13100 | 0.00000 | .03483 | .00029 | .00029 |
| 27 | -.10500 | 0.00000 | .03365 | .00200 | .00200 |
| 28 | -.07250 | 0.00000 | .03295 | .00314 | .00314 |
| 29 | -.02750 | 0.00000 | .03312 | .00325 | .00325 |

TOTAL COEFFICIENTS

CDII/CL**2 = .15956 CT= .15098 CS= .29455

KP , KV AND RESPECTIVE CHORDWISE CENTROIDS FOR EACH PLANFORM

PLANFORM NO. 1

| | | |
|---|---|---|
| KP= | 1.28879 | CENTROID AT -14.39074 |
| KV LE= | 1.55287 | CENTROID AT -14.70269 |
| KV SE= | .22241 | CENTROID AT -19.26927 |

PLANFORM NO. 2

| | | |
|---|---|---|
| KP= | 1.91113 | CENTROID AT -26.24069 |
| KV LE= | 1.04260 | CENTROID AT -26.77147 |
| KV SE= | .45948 | CENTROID AT -29.83309 |

PERFORMANCE CHARACTERISTICS FOR PLANFORM 1

| ALPHA | CN | CLP | CLP+CLVLE | CLP+CLVSE | CL | CMP | CMP+CMVLE | CMP+CMVSE | CM | CD | CL**2/(PI*AR) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2.0000 | .0471 | .0449 | .0468 | .0452 | .0471 | -.0705 | -.0735 | -.0711 | -.0741 | .0016 | .0003 |
| 4.0000 | .0983 | .0895 | .0970 | .0905 | .0981 | -.1407 | -.1528 | -.1429 | -.1550 | .0069 | .0012 |
| 6.0000 | .1534 | .1332 | .1501 | .1357 | .1525 | -.2101 | -.2373 | -.2152 | -.2424 | .0160 | .0030 |
| 8.0000 | .2120 | .1759 | .2057 | .1802 | .2099 | -.2786 | -.3268 | -.2876 | -.3358 | .0295 | .0056 |
| 10.0000 | .2739 | .2170 | .2632 | .2237 | .2698 | -.3457 | -.4207 | -.3597 | -.4348 | .0476 | .0093 |
| 12.0000 | .3388 | .2564 | .3220 | .2658 | .3314 | -.4111 | -.5186 | -.4313 | -.5388 | .0704 | .0140 |
| 14.0000 | .4064 | .2935 | .3817 | .3062 | .3944 | -.4745 | -.6201 | -.5018 | -.6474 | .0983 | .0198 |
| 16.0000 | .4764 | .3282 | .4417 | .3445 | .4579 | -.5356 | -.7246 | -.5711 | -.7601 | .1313 | .0267 |
| 18.0000 | .5483 | .3602 | .5013 | .3804 | .5215 | -.5940 | -.8317 | -.6386 | -.8763 | .1694 | .0346 |
| 20.0000 | .6219 | .3892 | .5599 | .4137 | .5844 | -.6496 | -.9407 | -.7043 | -.9953 | .2127 | .0435 |
| 22.0000 | .6968 | .4150 | .6171 | .4440 | .6460 | -.7021 | -1.0512 | -.7676 | -1.1168 | .2610 | .0531 |
| 24.0000 | .7726 | .4375 | .6722 | .4711 | .7058 | -.7511 | -1.1627 | -.8283 | -1.2400 | .3142 | .0634 |
| 26.0000 | .8489 | .4564 | .7246 | .4948 | .7630 | -.7964 | -1.2746 | -.8862 | -1.3643 | .3722 | .0741 |
| 28.0000 | .9255 | .4717 | .7739 | .5150 | .8172 | -.8379 | -1.3863 | -.9408 | -1.4892 | .4345 | .0850 |
| 30.0000 | 1.0019 | .4833 | .8195 | .5315 | .8677 | -.8753 | -1.4973 | -.9920 | -1.6141 | .5009 | .0959 |
| 32.0000 | 1.0777 | .4912 | .8610 | .5441 | .9139 | -.9084 | -1.6071 | -1.0395 | -1.7383 | .5711 | .1064 |
| 34.0000 | 1.1526 | .4953 | .8979 | .5530 | .9555 | -.9371 | -1.7151 | -1.0831 | -1.8612 | .6445 | .1163 |
| 36.0000 | 1.2262 | .4958 | .9299 | .5580 | .9920 | -.9612 | -1.8209 | -1.1226 | -1.9822 | .7207 | .1253 |
| 38.0000 | 1.2982 | .4927 | .9565 | .5591 | 1.0230 | -.9806 | -1.9238 | -1.1577 | -2.1008 | .7992 | .1332 |
| 40.0000 | 1.3681 | .4861 | .9776 | .5565 | 1.0480 | -.9953 | -2.0234 | -1.1883 | -2.2164 | .8794 | .1398 |
| 42.0000 | 1.4357 | .4763 | .9929 | .5503 | 1.0669 | -1.0051 | -2.1192 | -1.2142 | -2.3283 | .9607 | .1449 |
| 44.0000 | 1.5007 | .4633 | 1.0023 | .5405 | 1.0795 | -1.0100 | -2.2107 | -1.2354 | -2.4361 | 1.0424 | .1484 |
| 46.0000 | 1.5626 | .4474 | 1.0055 | .5273 | 1.0855 | -1.0100 | -2.2976 | -1.2517 | -2.5393 | 1.1241 | .1500 |
| 48.0000 | 1.6213 | .4288 | 1.0027 | .5110 | 1.0849 | -1.0051 | -2.3793 | -1.2631 | -2.6372 | 1.2049 | .1498 |
| 50.0000 | 1.6764 | .4079 | .9937 | .4918 | 1.0776 | -.9953 | -2.4555 | -1.2694 | -2.7296 | 1.2842 | .1478 |

PERFORMANCE CHARACTERISTICS FOR PLANFORM 2

| ALPHA | CN | CLP | CLP+CLVLE | CLP+CLVSE | CL | CMP | CMP+CMVLE | CMP+CMVSE | CM | CD | CL**2/(PI*AR) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2.0000 | .0685 | .0666 | .0679 | .0672 | .0684 | -.1906 | -.1943 | -.1924 | -.1962 | .0024 | .0006 |
| 4.0000 | .1403 | .1327 | .1377 | .1349 | .1400 | -.3803 | -.3951 | -.3876 | -.4024 | .0098 | .0025 |
| 6.0000 | .2151 | .1976 | .2089 | .2026 | .2139 | -.5682 | -.6014 | -.5845 | -.6177 | .0225 | .0058 |
| 8.0000 | .2925 | .2608 | .2808 | .2696 | .2896 | -.7533 | -.8122 | -.7822 | -.8411 | .0407 | .0107 |
| 10.0000 | .3721 | .3219 | .3528 | .3355 | .3665 | -.9347 | -1.0264 | -.9797 | -1.0714 | .0646 | .0171 |
| 12.0000 | .4536 | .3802 | .4243 | .3996 | .4437 | -1.1115 | -1.2430 | -1.1761 | -1.3076 | .0943 | .0251 |
| 14.0000 | .5365 | .4353 | .4945 | .4614 | .5206 | -1.2830 | -1.4610 | -1.3704 | -1.5484 | .1298 | .0345 |
| 16.0000 | .6205 | .4868 | .5629 | .5203 | .5965 | -1.4481 | -1.6793 | -1.5616 | -1.7928 | .1710 | .0453 |
| 18.0000 | .7051 | .5342 | .6289 | .5759 | .6706 | -1.6063 | -1.8968 | -1.7489 | -2.0394 | .2179 | .0573 |
| 20.0000 | .7899 | .5772 | .6918 | .6277 | .7423 | -1.7566 | -2.1124 | -1.9313 | -2.2872 | .2702 | .0702 |
| 22.0000 | .8746 | .6155 | .7511 | .6752 | .8109 | -1.8983 | -2.3252 | -2.1080 | -2.5349 | .3276 | .0837 |
| 24.0000 | .9586 | .6487 | .8063 | .7182 | .8757 | -2.0308 | -2.5341 | -2.2780 | -2.7812 | .3899 | .0976 |
| 26.0000 | 1.0417 | .6768 | .8569 | .7562 | .9362 | -2.1534 | -2.7380 | -2.4405 | -3.0251 | .4566 | .1116 |
| 28.0000 | 1.1233 | .6995 | .9024 | .7889 | .9918 | -2.2656 | -2.9360 | -2.5948 | -3.2653 | .5273 | .1252 |
| 30.0000 | 1.2031 | .7167 | .9424 | .8162 | 1.0419 | -2.3666 | -3.1271 | -2.7401 | -3.5006 | .6015 | .1382 |
| 32.0000 | 1.2807 | .7284 | .9766 | .8378 | 1.0861 | -2.4562 | -3.3104 | -2.8757 | -3.7299 | .6786 | .1502 |
| 34.0000 | 1.3557 | .7345 | 1.0048 | .8536 | 1.1239 | -2.5338 | -3.4850 | -3.0009 | -3.9521 | .7581 | .1608 |
| 36.0000 | 1.4278 | .7352 | 1.0266 | .8637 | 1.1551 | -2.5990 | -3.6500 | -3.1152 | -4.1661 | .8392 | .1699 |
| 38.0000 | 1.4965 | .7306 | 1.0420 | .8679 | 1.1793 | -2.6516 | -3.8046 | -3.2178 | -4.3709 | .9214 | .1771 |
| 40.0000 | 1.5617 | .7209 | 1.0509 | .8663 | 1.1963 | -2.6912 | -3.9481 | -3.3085 | -4.5654 | 1.0038 | .1822 |
| 42.0000 | 1.6229 | .7062 | 1.0531 | .8591 | 1.2060 | -2.7178 | -4.0798 | -3.3867 | -4.7487 | 1.0859 | .1852 |
| 44.0000 | 1.6798 | .6870 | 1.0489 | .8465 | 1.2084 | -2.7311 | -4.1990 | -3.4520 | -4.9199 | 1.1669 | .1859 |
| 46.0000 | 1.7322 | .6634 | 1.0382 | .8285 | 1.2033 | -2.7311 | -4.3052 | -3.5041 | -5.0782 | 1.2461 | .1844 |
| 48.0000 | 1.7799 | .6359 | 1.0212 | .8057 | 1.1910 | -2.7178 | -4.3978 | -3.5428 | -5.2228 | 1.3227 | .1806 |
| 50.0000 | 1.8225 | .6049 | .9982 | .7782 | 1.1715 | -2.6912 | -4.4764 | -3.5679 | -5.3530 | 1.3961 | .1747 |

TOTAL PERFORMANCE CHARACTERISTICS

| ALPHA | CN | CLP | CLP+CLVLE | CLP+CLVSE | CL | CMP | CMP+CMVLE | CMP+CMVSE | CM | CD | CL**2/(PI*AR) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2.0000 | .1156 | .1115 | .1147 | .1124 | .1155 | -.2611 | -.2679 | -.2635 | -.2703 | .0040 | .0017 |
| 4.0000 | .2386 | .2221 | .2347 | .2254 | .2380 | -.5210 | -.5479 | -.5305 | -.5574 | .0166 | .0072 |
| 6.0000 | .3685 | .3308 | .3590 | .3382 | .3664 | -.7783 | -.8387 | -.7997 | -.8602 | .0385 | .0171 |
| 8.0000 | .5045 | .4367 | .4865 | .4498 | .4996 | -1.0318 | -1.1389 | -1.0698 | -1.1769 | .0702 | .0318 |
| 10.0000 | .6460 | .5389 | .6160 | .5592 | .6362 | -1.2803 | -1.4471 | -1.3395 | -1.5062 | .1122 | .0515 |
| 12.0000 | .7924 | .6365 | .7463 | .6654 | .7751 | -1.5226 | -1.7616 | -1.6074 | -1.8464 | .1648 | .0765 |
| 14.0000 | .9429 | .7288 | .8762 | .7675 | .9149 | -1.7574 | -2.0811 | -1.8722 | -2.1959 | .2281 | .1066 |
| 16.0000 | 1.0969 | .8150 | 1.0046 | .8648 | 1.0544 | -1.9837 | -2.4039 | -2.1327 | -2.5529 | .3023 | .1415 |
| 18.0000 | 1.2534 | .8944 | 1.1301 | .9563 | 1.1920 | -2.2003 | -2.7284 | -2.3876 | -2.9157 | .3873 | .1809 |
| 20.0000 | 1.4118 | .9664 | 1.2517 | 1.0414 | 1.3267 | -2.4062 | -3.0531 | -2.6356 | -3.2825 | .4829 | .2241 |
| 22.0000 | 1.5713 | 1.0305 | 1.3682 | 1.1192 | 1.4569 | -2.6004 | -3.3765 | -2.8756 | -3.6516 | .5886 | .2703 |
| 24.0000 | 1.7312 | 1.0862 | 1.4785 | 1.1893 | 1.5815 | -2.7819 | -3.6968 | -3.1063 | -4.0212 | .7041 | .3185 |
| 26.0000 | 1.8906 | 1.1332 | 1.5815 | 1.2510 | 1.6993 | -2.9498 | -4.0126 | -3.3267 | -4.3894 | .8288 | .3676 |
| 28.0000 | 2.0488 | 1.1712 | 1.6763 | 1.3039 | 1.8090 | -3.1034 | -4.3223 | -3.5356 | -4.7545 | .9618 | .4166 |
| 30.0000 | 2.2049 | 1.2000 | 1.7619 | 1.3476 | 1.9095 | -3.2419 | -4.6245 | -3.7321 | -5.1147 | 1.1025 | .4643 |
| 32.0000 | 2.3584 | 1.2195 | 1.8376 | 1.3819 | 2.0000 | -3.3646 | -4.9175 | -3.9152 | -5.4682 | 1.2497 | .5093 |
| 34.0000 | 2.5083 | 1.2298 | 1.9027 | 1.4066 | 2.0795 | -3.4708 | -5.2001 | -4.0840 | -5.8133 | 1.4026 | .5506 |
| 36.0000 | 2.6540 | 1.2310 | 1.9565 | 1.4216 | 2.1471 | -3.5602 | -5.4709 | -4.2377 | -6.1484 | 1.5600 | .5870 |
| 38.0000 | 2.7947 | 1.2233 | 1.9986 | 1.4270 | 2.2022 | -3.6322 | -5.7284 | -4.3755 | -6.4717 | 1.7206 | .6175 |
| 40.0000 | 2.9298 | 1.2070 | 2.0285 | 1.4228 | 2.2443 | -3.6865 | -5.9715 | -4.4968 | -6.7818 | 1.8832 | .6413 |
| 42.0000 | 3.0586 | 1.1825 | 2.0461 | 1.4094 | 2.2730 | -3.7229 | -6.1990 | -4.6009 | -7.0770 | 2.0466 | .6578 |
| 44.0000 | 3.1805 | 1.1502 | 2.0511 | 1.3869 | 2.2878 | -3.7411 | -6.4098 | -4.6874 | -7.3560 | 2.2093 | .6664 |
| 46.0000 | 3.2949 | 1.1108 | 2.0437 | 1.3559 | 2.2888 | -3.7411 | -6.6028 | -4.7559 | -7.6175 | 2.3701 | .6670 |
| 48.0000 | 3.4012 | 1.0647 | 2.0238 | 1.3167 | 2.2758 | -3.7229 | -6.7771 | -4.8059 | -7.8601 | 2.5276 | .6594 |
| 50.0000 | 3.4989 | 1.0128 | 1.9918 | 1.2700 | 2.2490 | -3.6865 | -6.9318 | -4.8373 | -8.0826 | 2.6803 | .6440 |

THIS CASE IS FINISHED

## APPENDIX C

## FORTRAN PROGRAM LISTING

This program was written in FORTRAN IV language, version 2.3, for the Control Data series 6000 computer systems with SCOPE 3.0 operating system and library tape. Minor modifications may be required prior to use with other computers. The program requires $53000_8$ words of storage on the Control Data 6600 computer system and consists of a main program, five overlays, and five subroutines. Each program or subroutine is identified in columns 73 to 75 by a 3-character identification. In addition, each of these parts is sequenced with a 4-digit number in columns 76 to 79. The following table is an index to the program listing:



The execution time for this program is similar to that for the program presented in reference 6.

```
      OVERLAY(WINGTL,0,0)                                                    MAI  10
      PROGRAM WINGAL(INPUT=201,OUTPUT=1001,TAPE5=INPUT,TAPE6=OUTPUT,TAPEMAI  20
     110=401)                                                                MAI  25
      COMMON /ALL/ BOT,M,BETA,PTEST,QTEST,TBLSCW(50),Q(200),PN(200),PV(2MAI  30
     100),ALP(200),S(200),PSI(200),PHI(50),ZH(50)                            MAI  40
      COMMON /TOTHRE/ CIR(200,2)                                             MAI  50
      COMMON /THREFOR/ CCAV(2,50),CLT,CLNT,NSSW,ALPD                         MAI  60
      COMMON /ONETHRE/ TWIST(2),CREF,SREF,CAVE,CLDES,STRUE,AR,ARTRUE,RTCMAI  70
     1DHT(2),CONFIG,NSSWSV(2),MSV(2),KBOT,PLAN,IPLAN,MACH,SSWWA(50),XL(2MAI  80
     2),XT(2),CLWB,CMCL,CLA(2),BLAIR(50),CLAMAR(2)                           MAI  90
      COMMON /MAINONE/ ICODEOF,TOTAL,AAN(2),XS(2),YS(2),KFCTS(2),XREG(25MAI 100
     1,2),YREG(25,2),AREG(25,2),DIH(25,2),MCD(25,2),XX(25,2),YY(25,2),ASMAI 110
     2(25,2),TTWD(25,2),MMCD(25,2),AN(2),ZZ(25,2),ITIPCOD                   MAI 120
      COMMON /CCRRDD/ TSPAN,TSPANA,KBIT                                      MAI 130
C                                                                            MAI 140
C        VORTEX LATTICE AERODYNAMIC COMPUTATION                              MAI 150
C             NASA-LRC PROGRAM NO. A2794                                     MAI 160
C                                                                            MAI 170
C                                                                            MAI 180
      ICODEOF=TOTAL=0                                                        MAI 190
      WINGTL=6LWINGTL                                                        MAI 200
      RECALL=6HRECALL                                                        MAI 210
10    CALL OVERLAY (WINGTL,1,0,RECALL)                                       MAI 220
      IF (ICODEOF.GT.0) GO TO 70                                             MAI 230
      IF (M.GT.200) GO TO 40                                                 MAI 240
      NSW=NSSWSV(1)+NSSWSV(2)                                                MAI 250
      IF (NSW.GT.50) GO TO 30                                                MAI 260
      ITSV=0                                                                 MAI 270
      DO 20 IT=1,IPLAN                                                       MAI 280
      IF (AN(IT).LE.25.) GO TO 20                                            MAI 290
      WRITE (6,100) IT,AN(IT)                                                MAI 300
      ITSV=1                                                                 MAI 310
20    CONTINUE                                                               MAI 320
      IF (ITSV.GT.0) GO TO 60                                                MAI 330
      GO TO 50                                                               MAI 340
30    WRITE (6,90) NSW                                                       MAI 350
      GO TO 60                                                               MAI 360
40    WRITE (6,80) M                                                         MAI 370
      GO TO 60                                                               MAI 380
50    CALL OVERLAY (WINGTL,2,0,RECALL)                                       MAI 390
      CALL OVERLAY (WINGTL,3,0,RECALL)                                       MAI 400
      IF (PTEST.EQ.1..OR.QTEST.EQ.1.) GO TO 60                               MAI 410
      CALL OVERLAY (WINGTL,4,0,RECALL)                                       MAI 420
      IF (ITIPCOD.EQ.1) CALL OVERLAY (WINGTL,5,0,RECALL)                     MAI 430
60    TOTAL=TOTAL-1.                                                         MAI 440
      GO TO 10                                                               MAI 450
70    STOP                                                                   MAI 460
C                                                                            MAI 470
C                                                                            MAI 480
C                                                                            MAI 490
80    FORMAT (1H1//10X,I6,93HHORSESHOE VORTICES LAIDOUT, THIS IS MORE THMAI 500
     1AN THE 200 MAXIMUM. THIS CONFIGURATION IS ABORTED.)                    MAI 510
90    FORMAT (1H1//10X,I6,101H ROWS OF HORSESHOE VORTICES LAIDOUT. THIS MAI 520
     1IS MORE THAN THE 50 MAXIMUM. THIS CONFIGURATION IS ABORTED.)           MAI 530
100   FORMAT (1H1//10X,8HPLANFORM,I6,4H HAS,I6,74H BREAKPOINTS. THE MAXIMAI 540
     1MUM DIMENSIONED IS 25. THE CONFIGURATION IS ABORTED.)                  MAI 550
      END                                                                    MAI 560-
```

# APPENDIX C

```
      SUBROUTINE INFSUB (BOT,FVI,FWI)                                    INF  10
      COMMON /INSUB23/ PSII,APHII,XXX,YYY,ZZZ,SNN,TOLRNC                 INF  20
      FC=COS(PSII)                                                       INF  30
      FS=SIN(PSII)                                                       INF  40
      FT=FS/FC                                                           INF  50
C                                                                        INF  60
C                                                                        INF  70
      FPC=COS(APHII)                                                     INF  80
      FPS=SIN(APHII)                                                     INF  90
      FPT=FPS/FPC                                                        INF 100
      F1=XXX+SNN*FT*FPC                                                  INF 110
      F2=YYY+SNN*FPC                                                     INF 120
      F3=ZZZ+SNN*FPS                                                     INF 130
      F4=XXX-SNN*FT*FPC                                                  INF 140
      F5=YYY-SNN*FPC                                                     INF 150
      F6=ZZZ-SNN*FPS                                                     INF 160
      FFA=(XXX**2+(YYY*FPS)**2+FPC**2*((YYY*FT)**2+(ZZZ/FC)**2-2.*XXX*YYINF 170
     1Y*FT)-2.*ZZZ*FPC*(YYY*FPS+XXX*FT*FPS))                             INF 180
      FFB=(F1*F1+F2*F2+F3*F3)**.5                                        INF 190
      FFC=(F4*F4+F5*F5+F6*F6)**.5                                        INF 200
      FFD=F5*F5+F6*F6                                                    INF 210
      FFE=F2*F2+F3*F3                                                    INF 220
      FFF=(F1*FPC*FT+F2*FPC+F3*FPS)/FFB-(F4*FPC*FT+F5*FPC+F6*FPS)/FFC    INF 230
C                                                                        INF 240
C                                                                        INF 250
C     THE TOLERANCE SET AT THIS POINT IN THE PROGRAM MAY NEED TO BE      INF 260
C     CHANGED FOR COMPUTERS OTHER THAN THE CDC 6000 SERIES               INF 270
C                                                                        INF 280
C                                                                        INF 290
      IF (ABS(FFA).LT.(BOT*15.E-5)**2) GO TO 10                          INF 300
      FVONE=(XXX*FPS-ZZZ*FT*FPC)*FFF/FFA                                 INF 310
      FWONE=(YYY*FT-XXX)*FFF/FFA*FPC                                     INF 320
      GO TO 20                                                           INF 330
10    FVONE=FWONE=0.                                                     INF 340
C                                                                        INF 350
20    IF (ABS(FFD).LT.TOLRNC) GO TO 30                                   INF 360
      FVTWO=F6*(1.-F4/FFC)/FFD                                           INF 370
      FWTWO=-F5*(1.-F4/FFC)/FFD                                          INF 380
      GO TO 40                                                           INF 390
30    FVTWO=FWTWO=0.                                                     INF 400
C                                                                        INF 410
40    IF (ABS(FFE).LT.TOLRNC) GO TO 50                                   INF 420
      FVTHRE=-F3*(1.-F1/FFB)/FFE                                         INF 430
      FWTHRE=F2*(1.-F1/FFB)/FFE                                          INF 440
      GO TO 60                                                           INF 450
50    FVTHRE=FWTHRE=0.                                                   INF 460
C                                                                        INF 470
60    FVI=FVONE+FVTWO+FVTHRE                                             INF 480
      FWI=FWONE+FWTWO+FWTHRE                                             INF 490
      RETURN                                                             INF 500
      END                                                                INF 510-
```

```
      OVERLAY(WINGTL,1,0)                                                    GEO  10
      PROGRAM GEOMTRY                                                        GEO  20
      DIMENSION XREF(25), YREF(25), SAR(25), A(25), RSAR(25), X(25), Y(2GEO  30
     15), BOTSV(2), SA(2), VBORD(51), SPY(50,2), KFX(2), IYL(50,2), IYT(GEO  40
     250,2)                                                                  GEO  50
      COMMON /ALL/ BOT,M,BETA,PTEST,QTEST,TBLSCW(50),Q(200),PN(200),PV(2GEO  60
     100),ALP(200),S(200),PSI(200),PHI(50),ZH(50)                            GEO  70
      COMMON /ONETHRE/ TWIST(2),CREF,SREF,CAVE,CLDES,STRUE,AR,ARTRUE,RTCGEO  80
     1DHT(2),CONFIG,NSSWSV(2),MSV(2),KBOT,PLAN,IPLAN,MACH,SSWWA(50),XL(2GEO  90
     2),XT(2),CLWB,CMCL,CLA(2),BLAIR(50),CLAMAR(2)                           GEO 100
      COMMON /MAINONE/ ICODEOF,TOTAL,AAN(2),XS(2),YS(2),KFCTS(2),XREG(25GEO 110
     1,2),YREG(25,2),AREG(25,2),DIH(25,2),MCD(25,2),XX(25,2),YY(25,2),ASGEO 120
     2(25,2),TTWD(25,2),MMCD(25,2),AN(2),ZZ(25,2),ITIPCOD                    GEO 130
      COMMON /CORRDO/ TSPAN,TSPANA,KBIT                                      GEO 140
      REAL MACH                                                              GEO 150
C                                                                            GEO 160
C                                                                            GEO 170
C       PART ONE - GEOMETRY COMPUTATION                                      GEO 180
C                                                                            GEO 190
C                   SECTION ONE - INPUT OF REFERENCE WING POSITION           GEO 200
C                                                                            GEO 210
C                                                                            GEO 220
      IF (TOTAL.EQ.0.0) RTCDHT(1)=RTCDHT(2)=XL(2)=XT(2)=0.0                  GEO 230
      YTOL=1.E-10                                                            GEO 240
      AZY=1.E+13                                                             GEO 250
      PIT=1.5707963                                                          GEO 260
      RAD=57.29578                                                           GEO 270
      IF (TOTAL.GT.0.) GO TO 70                                              GEO 280
C                                                                            GEO 290
C                                                                            GEO 300
C     SET PLAN EQUAL TO 1. FOR A WING ALONE COMPUTAION - EVEN FOR A          GEO 310
C     VARIABLE SWEEP WING                                                    GEO 320
C     SET PLAN EQUAL TO 2. FOR A WING - TAIL COMBINATION                     GEO 330
C                                                                            GEO 340
C     SET TOTAL EQUAL TO THE NUMBER OF SETS                                  GEO 350
C       OF GROUP TWO DATA PROVIDED                                           GEO 360
C                                                                            GEO 370
      READ (5,880) PLAN,TOTAL,CREF,SREF                                      GEO 380
      IF (ENDFILE 5) 830,10                                                  GEO 390
10    IPLAN=PLAN                                                             GEO 400
C                                                                            GEO 410
C                                                                            GEO 420
C     SET AAN(IT) EQUAL TO THE MAXIMUM NUMBER OF CURVES REQUIRED TO          GEO 430
C     DEFINE THE PLANFORM PERIMETER OF THE (IT) PLANFORM.                    GEO 440
C                                                                            GEO 450
C     SET RTCDHT(IT) EQUAL TO THE ROOT CHORD HEIGHT OF THE LIFTING           GEO 460
C     SURFACE (IT),WHOSE PERIMETER POINTS ARE BEING READ IN, WITH            GEO 470
C     RESPECT TO THE WING ROOT CHORD HEIGHT                                  GEO 480
C                                                                            GEO 490
      WRITE (6,860)                                                          GEO 500
      DO 60 IT=1,IPLAN                                                       GEO 510
      READ (5,880) AAN(IT),XS(IT),YS(IT),RTCDHT(IT)                          GEO 520
      N=AAN(IT)                                                              GEO 530
      N1=N+1                                                                 GEO 540
      MAK=0                                                                  GEO 550
      IF (IPLAN.EQ.1) PRTCON=10H                                             GEO 560
      IF (IPLAN.EQ.2.AND.IT.EQ.1) PRTCON=10H    FIRST                        GEO 570
      IF (IPLAN.EQ.2.AND.IT.EQ.2) PRTCON=10H   SECOND                        GEO 580
      WRITE (6,870) PRTCON,N,RTCDHT(IT),XS(IT),YS(IT)                        GEO 590
      WRITE (6,990)                                                          GEO 600
```

```
      DO 50 I=1,N1                                                          GEO 610
      READ (5,880) XREG(I,IT),YREG(I,IT),DIH(I,IT),AMCD                     GEO 620
      MCD(I,IT)=AMCD                                                        GEO 630
      IF (I.EQ.1) GO TO 50                                                  GEO 640
      IF (MAK.NE.0.OR.MCD(I-1,IT).NE.2) GO TO 20                            GEO 650
      MAK=I-1                                                               GEO 660
20    IF (ABS(YREG(I-1,IT)-YREG(I,IT)).LT.YTOL) GO TO 30                    GEO 670
      AREG(I-1,IT)=(XREG(I-1,IT)-XREG(I,IT))/(YREG(I-1,IT)-YREG(I,IT))      GEO 680
      ASWP=ATAN(AREG(I-1,IT))*RAD                                           GEO 690
      GO TO 40                                                              GEO 700
30    YREG(I,IT)=YREG(I-1,IT)                                               GEO 710
      AREG(I-1,IT)=AZY                                                      GEO 720
      ASWP=90.                                                              GEO 730
40    J=I-1                                                                 GEO 740
C                                                                           GEO 750
C     WRITE PLANFORM PERIMETER POINTS AND ANGLES                            GEO 760
C                                                                           GEO 770
      WRITE (6,960) J,XREG(J,IT),YREG(J,IT),ASWP,DIH(J,IT),MCD(J,IT)        GEO 780
      DIH(J,IT)=TAN(DIH(J,IT)/RAD)                                          GEO 790
50    CONTINUE                                                              GEO 800
      KFCTS(IT)=MAK                                                         GEO 810
      WRITE (6,960) N1,XREG(N1,IT),YREG(N1,IT)                              GEO 820
60    CONTINUE                                                              GEO 830
C                                                                           GEO 840
C                          PART 1 - SECTION 2                               GEO 850
C          READ GROUP 2 DATA AND COMPUTE DESIRED WING POSITION              GEO 860
C                                                                           GEO 870
C                                                                           GEO 880
C     SET SA(1),SA(2) EQUAL TO THE SWEEP ANGLE,IN DEGREES, FOR THE FIRSTGEO 890
C     CURVE(S) THAT CAN CHANGE SWEEP FOR EACH PLANFORM                      GEO 900
C                                                                           GEO 910
C     IF A PARTICULAR VALUE OF CL IS DESIRED AT WHICH THE LOADINGS ARE      GEO 920
C     TO BE COMPUTED, SET CLDES EQUAL TO THIS VALUE                         GEO 930
C     SET CLDES EQUAL TO 11. FOR A DRAG POLAR AT CL VALUES OF-.1 TO  1.0GEO 940
C                                                                           GEO 950
C     IF PTEST IS SET EQUAL TO ONE THE PROGRAM WILL COMPUTE  CLP            GEO 960
C     IF QTEST IS SET EQUAL TO ONE THE PROGRAM WILL COMPUTE  CMQ AND CLQGEO 970
C     DO NOT SET BOTH PTEST AND QTEST TO ONE FOR A SINGLE CONFIGURATION GEO 980
C                                                                           GEO 990
C     SET TWIST(1) OR TWIST(2) EQUAL TO 0. FOR A FLAT PLANFORM AND TO 1.GEO1000
C     FOR A PLANFORM THAT HAS TWIST AND/OR CAMBER                           GEO1010
C                                                                           GEO1020
C     SET ATPCOD TO ONE IF THE CONTRIBUTIONS TO LIFT,DRAG AND MOMENT        GEO1030
C     FROM SEPERATED FLOW AROUND THE LEADING AND/OR SIDE EDGES IS           GEO1040
C     DESIRED.   OTHERWISE SET ATPCOD TO ZERO.                              GEO1050
C                                                                           GEO1060
C                                                                           GEO1070
70    READ (5,950) CONFIG,SCW,VIC,MACH,CLDES,PTEST,QTEST,TWIST(1),SA(1),GEO1080
     1TWIST(2),SA(2),ATPCOD                                                 GEO1090
      ITIPCOD=ATPCOD                                                        GEO1100
      IF (ITIPCOD.NE.1) GO TO 110                                           GEO1110
      DO 100 IT=1,IPLAN                                                     GEO1120
      NBBG=AAN(IT)                                                          GEO1130
      DO 90 IBBG=2,NBBG                                                     GEO1140
      IF (YREG(IBBG,IT).EQ.YREG(IBBG+1,IT)) GO TO 80                        GEO1150
      GO TO 90                                                              GEO1160
80    IF (YREG(IBBG+2,IT).LT.YREG(IBBG+1,IT)) GO TO 90                      GEO1170
      IF (YREG(IBBG-1,IT).LT.YREG(IBBG,IT)) GO TO 90                        GEO1180
      XL(IT)=XREG(IBBG,IT)                                                  GEO1190
      XT(IT)=XREG(IBBG+1,IT)                                                GEO1200
```

```
      GO TO 100                                                          GE01210
90    CONTINUE                                                           GE01220
      XL(IT)=0.0                                                         GE01230
      XT(IT)=0.0                                                         GE01240
100   CONTINUE                                                           GE01250
110   CONTINUE                                                           GE01260
      WRITE (6,890) CONFIG                                               GE01270
      IF (ENDFILE 5) 830,120                                             GE01280
120   IF (PTEST.NE.0..AND.QTEST.NE.0.) GO TO 850                         GE01290
      IF (SCW.EQ.0.) GO TO 140                                           GE01300
      DO 130 I=1,50                                                      GE01310
130   TBLSCW(I)=SCW                                                      GE01320
      GO TO 150                                                          GE01330
140   READ (5,880) STA                                                   GE01340
      NSTA=STA                                                           GE01350
      READ (5,880) (TBLSCW(I),TBLSCW(I+1),TBLSCW(I+2),TBLSCW(I+3),TBLSCWGE01360
     1(I+4),TBLSCW(I+5),TBLSCW(I+6),TBLSCW(I+7),I=1,NSTA,8)              GE01370
150   DO 410 IT=1,IPLAN                                                  GE01380
      N=AAN(IT)                                                          GE01390
      N1=N+1                                                             GE01400
      DO 160 I=1,N                                                       GE01410
      XREF(I)=XREG(I,IT)                                                 GE01420
      YREF(I)=YREG(I,IT)                                                 GE01430
      A(I)=AREG(I,IT)                                                    GE01440
      RSAR(I)=ATAN(A(I))                                                 GE01450
      IF (A(I).EQ.AZY) RSAR(I)=PIT                                       GE01460
160   CONTINUE                                                           GE01470
      XREF(N1)=XREG(N1,IT)                                               GE01480
      YREF(N1)=YREG(N1,IT)                                               GE01490
      IF (KFCTS(IT).GT.0) GO TO 170                                      GE01500
      K=1                                                                GE01510
      SA(IT)=RSAR(1)*RAD                                                 GE01520
      GO TO 180                                                          GE01530
170   K=KFCTS(IT)                                                        GE01540
180   WRITE (6,920) K,SA(IT),IT                                          GE01550
      SB=SA(IT)/RAD                                                      GE01560
      IF (ABS(SB-RSAR(K)).GT.(.1/RAD)) GO TO 210                         GE01570
C     REFERENCE PLANFORM COORDINATES ARE STORED UNCHANGED FOR WINGS      GE01580
C           WITHOUT CHANGE IN SWEEP                                      GE01590
      DO 200 I=1,N                                                       GE01600
      X(I)=XREF(I)                                                       GE01610
      Y(I)=YREF(I)                                                       GE01620
      IF (RSAR(I).EQ.PIT) GO TO 190                                      GE01630
      A(I)=TAN(RSAR(I))                                                  GE01640
      GO TO 200                                                          GE01650
190   A(I)=AZY                                                           GE01660
200   SAR(I)=RSAR(I)                                                     GE01670
      X(N1)=XREF(N1)                                                     GE01680
      Y(N1)=YREF(N1)                                                     GE01690
      GO TO 390                                                          GE01700
C                                                                        GE01710
C     CHANGES IN WING SWEEP ARE MADE HERE                                GE01720
C                                                                        GE01730
210   IF (MCD(K,IT).NE.2) GO TO 840                                      GE01740
      KA=K-1                                                             GE01750
      DO 220 I=1,KA                                                      GE01760
      X(I)=XREF(I)                                                       GE01770
      Y(I)=YREF(I)                                                       GE01780
220   SAR(I)=RSAR(I)                                                     GE01790
C     DETERMINE LEADING EDGE INTERSECTION BETWEEN FIXED AND VARIABLE     GE01800
```

# APPENDIX C

```
C            SWEEP WING SECTIONS                                              GE01810
      SAR(K)=SB                                                               GE01820
      A(K)=TAN(SB)                                                            GE01830
      SAI=SB-RSAR(K)                                                          GE01840
      X(K+1)=XS(IT)+(XREF(K+1)-XS(IT))*COS(SAI)+(YREF(K+1)-YS(IT))*SIN(SGE01850
                                                                              GE01860
     1AI)                                                                     GE01870
      Y(K+1)=YS(IT)+(YREF(K+1)-YS(IT))*COS(SAI)-(XREF(K+1)-XS(IT))*SIN(SGE01880
     1AI)                                                                     GE01890
      IF (ABS(SB-SAR(K-1)).LT.(.1/RAD)) GO TO 230                             GE01900
      Y(K)=X(K+1)-X(K-1)-A(K)*Y(K+1)+A(K-1)*Y(K-1)                            GE01910
      Y(K)=Y(K)/(A(K-1)-A(K))                                                 GE01920
      X(K)=A(K)*X(K-1)-A(K-1)*X(K+1)+A(K-1)*A(K)*(Y(K+1)-Y(K-1))              GE01930
      X(K)=X(K)/(A(K)-A(K-1))                                                 GE01940
      GO TO 240                                                               GE01950
C     ELIMINATE EXTRANEOUS BREAKPOINTS                                        GE01960
230   X(K)=XREF(K-1)                                                          GE01970
      Y(K)=YREF(K-1)                                                          GE01980
      SAR(K)=SAR(K-1)                                                         GE01990
240   K=K+1                                                                   GE02000
C     SWEEP THE BREAKPOINTS ON THE VARIABLE SWEEP PANEL                       GE02010
C        (IT ALSO KEEPS SWEEP ANGLES IN FIRST OR FOURTH QUADRANTS)            GE02020
250   K=K+1                                                                   GE02030
      SAR(K-1)=SAI+RSAR(K-1)                                                  GE02040
260   IF (SAR(K-1).LE.PIT) GO TO 270                                          GE02050
      SAR(K-1)=SAR(K-1)-3.1415927                                             GE02060
      GO TO 260                                                               GE02070
270   IF (SAR(K-1).GE.(-PIT)) GO TO 280                                       GE02080
      SAR(K-1)=SAR(K-1)+3.1415927                                             GE02090
      GO TO 270                                                               GE02100
280   IF ((SAR(K-1)).LT..0) GO TO 290                                         GE02110
      IF (SAR(K-1)-PIT) 320,300,300                                           GE02120
290   IF (SAR(K-1)+PIT) 310,310,320                                           GE02130
300   A(K-1)=AZY                                                              GE02140
      GO TO 330                                                               GE02150
310   A(K-1)=-AZY                                                             GE02160
      GO TO 330                                                               GE02170
320   A(K-1)=TAN(SAR(K-1))                                                    GE02180
330   KK=MCD(K,IT)                                                            GE02190
      GO TO (350,340), KK                                                     GE02200
340   Y(K)=YS(IT)+(YREF(K)-YS(IT))*COS(SAI)-(XREF(K)-XS(IT))*SIN(SAI)         GE02210
      X(K)=XS(IT)+(XREF(K)-XS(IT))*COS(SAI)+(YREF(K)-YS(IT))*SIN(SAI)         GE02220
      GO TO 250                                                               GE02230
C     DETERMINE THE TRAILING EDGE INTERSECTION                                GE02240
C        BETWEEN FIXED AND VARIABLE SWEEP WING SECTIONS                       GE02250
350   IF (ABS(RSAR(K)-SAR(K-1)).LT.(.1/RAD)) GO TO 360                        GE02260
      Y(K)=XREF(K+1)-X(K-1)-A(K)*YREF(K+1)+A(K-1)*Y(K-1)                      GE02270
      Y(K)=Y(K)/(A(K-1)-A(K))                                                 GE02280
      X(K)=A(K)*X(K-1)-A(K-1)*XREF(K+1)+A(K-1)*A(K)*(YREF(K+1)-Y(K-1))        GE02290
      X(K)=X(K)/(A(K)-A(K-1))                                                 GE02300
      GO TO 370                                                               GE02310
360   X(K)=XREF(K+1)                                                          GE02320
      Y(K)=YREF(K+1)                                                          GE02330
370   K=K+1                                                                   GE02340
C     STORE REFERENCE PLANFORM COORDINATES ON INBOARD FIXED TRAILING          GE02350
C     EDGE                                                                    GE02360
      DO 380 I=K,N1                                                           GE02370
      X(I)=XREF(I)                                                            GE02380
      Y(I)=YREF(I)                                                            GE02390
380   SAR(I-1)=RSAR(I-1)                                                      GE02400
390   DO 400 I=1,N
```

```
      XX(I,IT)=X(I)                                                          GE02410
      YY(I,IT)=Y(I)                                                          GE02420
      MMCD(I,IT)=MCD(I,IT)                                                   GE02430
      TTWD(I,IT)=DIH(I,IT)                                                   GE02440
400   AS(I,IT)=A(I)                                                          GE02450
      XX(N1,IT)=X(N1)                                                        GE02460
      YY(N1,IT)=Y(N1)                                                        GE02470
      AN(IT)=AAN(IT)                                                         GE02480
410   CONTINUE                                                               GE02490
C                                                                            GE02500
C       LINE UP BREAKPOINTS AMONG PLANFORMS                                  GE02510
C                                                                            GE02520
      BOTSV(1)=BOTSV(2)=0.                                                   GE02530
      WRITE (6,980)                                                          GE02540
      DO 530 IT=1,IPLAN                                                      GE02550
      NIT=AN(IT)+1                                                           GE02560
      DO 470 ITT=1,IPLAN                                                     GE02570
      IF (ITT.EQ.IT) GO TO 470                                               GE02580
      NITT=AN(ITT)+1                                                         GE02590
      DO 460 I=1,NITT                                                        GE02600
      JPSV=0                                                                 GE02610
      DO 420 JP=1,NIT                                                        GE02620
      IF (YY(JP,IT).EQ.YY(I,ITT)) GO TO 460                                  GE02630
420   CONTINUE                                                               GE02640
      DO 430 JP=1,NIT                                                        GE02650
      IF (YY(JP,IT).LT.YY(I,ITT)) GO TO 440                                  GE02660
430   CONTINUE                                                               GE02670
      GO TO 460                                                              GE02680
440   JPSV=JP                                                                GE02690
      IND=NIT-(JPSV-1)                                                       GE02700
      DO 450 JP=1,IND                                                        GE02710
      K2=NIT-JP+2                                                            GE02720
      K1=NIT-JP+1                                                            GE02730
      XX(K2,IT)=XX(K1,IT)                                                    GE02740
      YY(K2,IT)=YY(K1,IT)                                                    GE02750
      MMCD(K2,IT)=MMCD(K1,IT)                                                GE02760
      AS(K2,IT)=AS(K1,IT)                                                    GE02770
450   TTWD(K2,IT)=TTWD(K1,IT)                                                GE02780
      YY(JPSV,IT)=YY(I,ITT)                                                  GE02790
      AS(JPSV,IT)=AS(JPSV-1,IT)                                              GE02800
      TTWD(JPSV,IT)=TTWD(JPSV-1,IT)                                          GE02810
      XX(JPSV,IT)=(YY(JPSV,IT)-YY(JPSV-1,IT))*AS(JPSV-1,IT)+XX(JPSV-1,IT     GE02820
     1)                                                                      GE02830
      MMCD(JPSV,IT)=MMCD(JPSV-1,IT)                                          GE02840
      AN(IT)=AN(IT)+1.                                                       GE02850
      NIT=NIT+1                                                              GE02860
460   CONTINUE                                                               GE02870
470   CONTINUE                                                               GE02880
C                                                                            GE02890
C     SEQUENCE WING COORDINATES FROM TIP TO ROOT                             GE02900
C                                                                            GE02910
      N1=AN(IT)+1.                                                           GE02920
      DO 480 I=1,N1                                                          GE02930
480   Q(I)=YY(I,IT)                                                          GE02940
      DO 520 J=1,N1                                                          GE02950
      HIGH=1.                                                                GE02960
      DO 490 I=1,N1                                                          GE02970
      IF ((Q(I)-HIGH).GE.0.) GO TO 490                                       GE02980
      HIGH=Q(I)                                                              GE02990
      IH=I                                                                   GE03000
```

```
490   CONTINUE                                                          GE03010
      IF (J.NE.1) GO TO 500                                             GE03020
      BOTSV(IT)=HIGH                                                    GE03030
      KFX(IT)=IH                                                        GE03040
500   Q(IH)=1.                                                          GE03050
      SPY(J,IT)=HIGH                                                    GE03060
      IF (IH.GT.KFX(IT)) GO TO 510                                      GE03070
      IYL(J,IT)=1                                                       GE03080
      IYT(J,IT)=0                                                       GE03090
      GO TO 520                                                         GE03100
510   IYL(J,IT)=0                                                       GE03110
      IYT(J,IT)=1                                                       GE03120
520   CONTINUE                                                          GE03130
530   CONTINUE                                                          GE03140
C                                                                       GE03150
C     SELECT MAXIMUM B/2 AS THE WING SEMISPAN.   IF BOTH FIRST AND      GE03160
C     SECOND PLANFORMS HAVE SAME SEMISPAN THEN THE SECOND PLANFORM IS   GE03170
C     TAKEN TO BE THE WING.                                             GE03180
C                                                                       GE03190
      KBOT=1                                                            GE03200
      IF (BOTSV(1).GE.BOTSV(2)) KBOT=2                                  GE03210
      BOT=BOTSV(KBOT)                                                   GE03220
C                                                                       GE03230
C     COMPUTE NOMINAL HORSESHOE VORTEX WIDTH ALONG WING SURFACE         GE03240
C                                                                       GE03250
      TSPAN=0                                                           GE03260
      ISAVE=KFX(KBOT)-1                                                 GE03270
      I=KFX(KBOT)-2                                                     GE03280
540   IF (I.EQ.0) GO TO 550                                             GE03290
      IF (TTWD(I,KBOT).EQ.TTWD(ISAVE,KBOT)) GO TO 560                   GE03300
550   CTWD=COS(ATAN(TTWD(ISAVE,KBOT)))                                  GE03310
      TLGTH=(YY(ISAVE+1,KBOT)-YY(I+1,KBOT))/CTWD                        GE03320
      TSPAN=TSPAN+TLGTH                                                 GE03330
      IF (I.EQ.0) GO TO 570                                             GE03340
      ISAVE=I                                                           GE03350
560   I=I-1                                                             GE03360
      GO TO 540                                                         GE03370
570   VI=TSPAN/VIC                                                      GE03380
      VSTOL=VI/2                                                        GE03390
      TSPANA=0.                                                         GE03400
      KBIT=2                                                            GE03410
      IF (IPLAN.EQ.1) GO TO 610                                         GE03420
      IF (KBOT.EQ.2) KBIT=1                                             GE03430
      ISAVEA=KFX(KBIT)-1                                                GE03440
      IA=KFX(KBIT)-2                                                    GE03450
580   IF (IA.EQ.0) GO TO 590                                            GE03460
      IF (TTWD(IA,KBIT).EQ.TTWD(ISAVEA,KBIT)) GO TO 600                 GE03470
590   CTWDA=COS(ATAN(TTWD(ISAVEA,KBIT)))                                GE03480
      TLGTHA=(YY(ISAVEA+1,KBIT)-YY(IA+1,KBIT))/CTWDA                    GE03490
      TSPANA=TSPANA+TLGTHA                                              GE03500
      IF (IA.EQ.0) GO TO 610                                            GE03510
      ISAVEA=IA                                                         GE03520
600   IA=IA-1                                                           GE03530
      GO TO 580                                                         GE03540
610   CONTINUE                                                          GE03550
C                                                                       GE03560
C     ELIMINATE PLANFORM BREAKPOINTS WHICH ARE WITHIN (B/2)/2000 UNITS  GE03570
C     LATERALLY                                                         GE03580
C                                                                       GE03590
      DO 630 IT=1,IPLAN                                                 GE03600
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      N=AN(IT)                                                          GE03610
      N1=N+1                                                            GE03620
      DO 630 J=1,N                                                      GE03630
      AA=ABS(SPY(J,IT)-SPY(J+1,IT))                                     GE03640
      IF (AA.EQ.0..OR.AA.GT.ABS(TSPAN/2000.)) GO TO 630                 GE03650
      IF (AA.GT.YTOL) WRITE (6,1010) SPY(J+1,IT),SPY(J,IT)              GE03660
      DO 620 I=1,N1                                                     GE03670
      IF (YY(I,IT).NE.SPY(J+1,IT)) GO TO 620                            GE03680
      YY(I,IT)=SPY(J,IT)                                                GE03690
  620 CONTINUE                                                          GE03700
      SPY(J+1,IT)=SPY(J,IT)                                             GE03710
  630 CONTINUE                                                          GE03720
C                                                                       GE03730
C     COMPUTE Z COORDINATES                                             GE03740
C                                                                       GE03750
      DO 670 IT=1,IPLAN                                                 GE03760
      JM=N1=AN(IT)+1.                                                   GE03770
      DO 640 JZ=1,N1                                                    GE03780
  640 ZZ(JZ,IT)=RTCDHT(IT)                                              GE03790
      JZ=1                                                              GE03800
  650 JZ=JZ+1                                                           GE03810
      IF (JZ.GT.KFX(IT)) GO TO 660                                      GE03820
      ZZ(JZ,IT)=ZZ(JZ-1,IT)+(YY(JZ,IT)-YY(JZ-1,IT))*TTWD(JZ-1,IT)      GE03830
      GO TO 650                                                         GE03840
  660 JM=JM-1                                                           GE03850
      IF (JM.EQ.KFX(IT)) GO TO 670                                      GE03860
      ZZ(JM,IT)=ZZ(JM+1,IT)+(YY(JM,IT)-YY(JM+1,IT))*TTWD(JM,IT)         GE03870
      GO TO 660                                                         GE03880
  670 CONTINUE                                                          GE03890
C                                                                       GE03900
C     WRITE PLANFORM PERIMETER POINTS ACTUALLY USED IN THE COMPUTATIONS  GE03910
C                                                                       GE03920
      WRITE (6,900)                                                     GE03930
      DO 690 IT=1,IPLAN                                                 GE03940
      N=AN(IT)                                                          GE03950
      N1=N+1                                                            GE03960
      IF (IT.EQ.2) WRITE (6,1000)                                       GE03970
      DO 680 KK=1,N                                                     GE03980
      TOUT=ATAN(TTWD(KK,IT))*RAD                                        GE03990
      AOUT=ATAN(AS(KK,IT))*RAD                                          GE04000
      IF (AS(KK,IT).EQ.AZY) AOUT=90.                                    GE04010
      WRITE (6,910) KK,XX(KK,IT),YY(KK,IT),ZZ(KK,IT),AOUT,TOUT,MMCD(KK,IGE04020
     1IT)                                                               GE04030
  680 CONTINUE                                                          GE04040
      WRITE (6,910) N1,XX(N1,IT),YY(N1,IT),ZZ(N1,IT)                    GE04050
  690 CONTINUE                                                          GE04060
C                                                                       GE04070
C     PART ONE - SECTION THREE - LAY OUT YAWED HORSESHOE VORTICES       GE04080
C                                                                       GE04090
      STRUE=0.                                                          GE04100
      NSSWSV(1)=NSSWSV(2)=MSV(1)=MSV(2)=0                               GE04110
      DO 780 IT=1,IPLAN                                                 GE04120
      N1=AN(IT)+1.                                                      GE04130
      I=0                                                               GE04140
      J=1                                                               GE04150
      YIN=BOTSV(IT)                                                     GE04160
      ILE=ITE=KFX(IT)                                                   GE04170
C     DETERMINE SPANWISE BORDERS OF HORSESHOE VORTICES                  GE04180
  700 IXL=IXT=0                                                         GE04190
      I=I+1                                                             GE04200
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      IF (YIN.GE.(SPY(J,IT)+VSTOL)) GO TO 710                           GE04210
C     BORDER IS WITHIN VORTEX SPACING TOLERANCE (VSTOL) OF BREAKPOINT   GE04220
C     THEREFORE USE THE NEXT BREAKPOINT INBOARD FOR THE BORDER          GE04230
      VBORD(I)=YIN                                                      GE04240
      GO TO 740                                                         GE04250
C     USE NOMINAL VORTEX SPACING TO DETERMINE THE BORDER                GE04260
710   VBORD(I)=SPY(J,IT)                                                GE04270
C     COMPUTE SUBSCRIPTS ILE AND ITE TO INDICATE WHICH                  GE04280
C     BREAKPOINTS ARE ADJACENT AND WHETHER THEY ARE ON THE WING LEADING GE04290
C       EDGE OR THE TRAILING EDGE                                       GE04300
720   IF (J.GE.N1) GO TO 730                                            GE04310
      IF (SPY(J,IT).NE.SPY(J+1,IT)) GO TO 730                           GE04320
      IXL=IXL+IYL(J,IT)                                                 GE04330
      IXT=IXT+IYT(J,IT)                                                 GE04340
      J=J+1                                                             GE04350
      GO TO 720                                                         GE04360
730   YIN=SPY(J,IT)                                                     GE04370
      IXL=IXL+IYL(J,IT)                                                 GE04380
      IXT=IXT+IYT(J,IT)                                                 GE04390
      J=J+1                                                             GE04400
740   CPHI=COS(ATAN(TTWD(ILE,IT)))                                      GE04410
      IPHI=ILE-IXL                                                      GE04420
      IF (J.GE.N1) IPHI=1                                               GE04430
      YIN=YIN-VI*COS(ATAN(TTWD(IPHI,IT)))                               GE04440
      IF (I.NE.1) GO TO 760                                             GE04450
750   ILE=ILE-IXL                                                       GE04460
      ITE=ITE+IXT                                                       GE04470
      GO TO 700                                                         GE04480
C     COMPUTE COORDINATES FOR CHORDWISE ROW OF HORSESHOE VORTICES       GE04490
760   YQ=(VBORD(I-1)+VBORD(I))/2.                                       GE04500
      HW=(VBORD(I)-VBORD(I-1))/2.                                       GE04510
      IM1=I-1+NSSWSV(1)                                                 GE04520
      ZH(IM1)=ZZ(ILE,IT)+(YQ-YY(ILE,IT))*TTWD(ILE,IT)                   GE04530
      PHI(IM1)=TTWD(ILE,IT)                                             GE04540
      SSWWA(IM1)=AS(ILE,IT)                                             GE04550
      XLE=XX(ILE,IT)+AS(ILE,IT)*(YQ-YY(ILE,IT))                         GE04560
      XTE=XX(ITE,IT)+AS(ITE,IT)*(YQ-YY(ITE,IT))                         GE04570
      XLOCAL=(XLE-XTE)/TBLSCW(IM1)                                      GE04580
C                                                                       GE04590
C     COMPUTE WING AREA PROJECTED TO THE X - Y PLANE                    GE04600
C                                                                       GE04610
      STRUE=STRUE+XLOCAL*TBLSCW(IM1)*(HW*2.)*2.                         GE04620
C                                                                       GE04630
      NSCW=TBLSCW(IM1)                                                  GE04640
      DO 770 JCW=1,NSCW                                                 GE04650
      AJCW=JCW-1                                                        GE04660
      XLEL=XLE-AJCW*XLOCAL                                              GE04670
      NTS=JCW+MSV(1)+MSV(2)                                             GE04680
      PN(NTS)=XLEL-.25*XLOCAL                                           GE04690
      PV(NTS)=XLEL-.75*XLOCAL                                           GE04700
      PSI(NTS)=((XLE-PN(NTS))*AS(ITE,IT)+(PN(NTS)-XTE)*AS(ILE,IT))/(XLE-GE04710
     1XTE)                                                              GE04720
      S(NTS)=HW/CPHI                                                    GE04730
      Q(NTS)=YQ                                                         GE04740
770   CONTINUE                                                          GE04750
      MSV(IT)=MSV(IT)+NSCW                                              GE04760
C                                                                       GE04770
C     TEST TO DETERMINE WHEN WING ROOT IS REACHED                       GE04780
      IF (VBORD(I).LT.YREG(1,IT)) GO TO 750                             GE04790
C                                                                       GE04800
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      NSSWSV(IT)=I-1                                                    GE04810
780   CONTINUE                                                          GE04820
      M=MSV(1)*MSV(2)                                                   GE04830
C                                                                       GE04840
C     COMPUTE ASPECT RATIO  AND  AVERAGE CHORD                          GE04850
C                                                                       GE04860
      BOT=-BOT                                                          GE04870
      AR=4.*BOT*BOT/SREF                                                GE04880
      ARTRUE=4.*BOT*BOT/STRUE                                           GE04890
      CAVE=STRUE/(2.*BOT)                                               GE04900
      BETA=(1.-MACH*MACH)**.5                                           GE04910
      NVTWO=0                                                           GE04920
      DO 810 IT=1,IPLAN                                                 GE04930
      NVONE=1+(IT-1)*MSV(1)                                             GE04940
      NVTWO=NVTWO+MSV(IT)                                               GE04950
      IF (TWIST(IT).LE.0.) GO TO 790                                    GE04960
      READ (5,880) (ALP(NV),ALP(NV+1),ALP(NV+2),ALP(NV+3),ALP(NV+4),ALP(GE04970
     1NV+5),ALP(NV+6),ALP(NV+7),NV=NVONE,NVTWO,8)                       GE04980
      GO TO 810                                                         GE04990
790   DO 800 NV=NVONE,NVTWO                                             GE05000
800   ALP(NV)=0.                                                        GE05010
810   CONTINUE                                                          GE05020
      WRITE (6,1040) M                                                  GE05030
      WRITE (6,1050) (IT,MSV(IT),NSSWSV(IT),IT=1,IPLAN)                 GE05040
      IF (SCW.NE.0.) WRITE (6,1020) SCW                                 GE05050
      IF (SCW.EQ.0.) WRITE (6,1030) (TBLSCW(I),I=1,NSTA)                GE05060
C                                                                       GE05070
C     APPLY PRANDTL-GLAUERT CORRECTION                                  GE05080
C                                                                       GE05090
      DO 820 NV=1,M                                                     GE05100
      PSI(NV)=ATAN(PSI(NV)/BETA)                                        GE05110
      PN(NV)=PN(NV)/BETA                                                GE05120
820   PV(NV)=PV(NV)/BETA                                                GE05130
      RETURN                                                            GE05140
830   ICODEOF=1                                                         GE05150
      WRITE (6,930) CONFIG                                              GE05160
      RETURN                                                            GE05170
840   ICODEOF=2                                                         GE05180
      WRITE (6,940) K,IT                                                GE05190
      RETURN                                                            GE05200
850   ICODEOF=3                                                         GE05210
      WRITE (6,970) PTEST,QTEST                                         GE05220
      RETURN                                                            GE05230
C                                                                       GE05240
C                                                                       GE05250
C                                                                       GE05260
860   FORMAT (1H1//63X,13HGEOMETRY DATA)                                GE05270
870   FORMAT (///45X,A10,22HREFERENCE PLANFORM HAS,I3,7H CURVES//12X,19HGE05280
     1ROOT CHORD HEIGHT =,F12.5,4X,29HVARIABLE SWEEP PIVOT POSITION,4X,6GE05290
     2HX(S) =,F12.5,5X,6HY(S) =,F12.5//46X,40HBREAK POINTS FOR THE REFERGE05300
     3ENCE PLANFORM /)                                                  GE05310
880   FORMAT (8F10.4)                                                   GE05320
890   FORMAT (1H1//47X,17HCONFIGURATION NO.,F8.0/)                      GE05330
900   FORMAT (22X,5HPOINT,6X,1HX,11X,1HY,11X,1HZ,10X,5HSWEEP,7X,8HDIHEDRGE05340
     1AL,4X,4HMOVE/68X,5HANGLE,8X,5HANGLE,6X,4HCODE/)                   GE05350
910   FORMAT (20X,I5,3F12.5,2F14.5,I6)                                  GE05360
920   FORMAT (/40X,5HCURVE,I3,9H IS SWEPT,F12.5,20H DEGREES ON PLANFORM,GE05370
     1I3)                                                               GE05380
930   FORMAT (1H1///41X,43HEND OF FILE ENCOUNTERED AFTER CONFIGURATION,FGE05390
     17.0)                                                              GE05400
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940   FORMAT (1H1///18X,45HTHE FIRST VARIABLE SWEEP CURVE SPECIFIED (K =GE05410
     1,I3,44H ) DOES NOT HAVE AN M CODE OF 2 FOR PLANFORM,I4)          GE05420
950   FORMAT (8F5.1,F10.4,F5.1,F10.4,F5.1)                             GE05430
960   FORMAT (26X,I5,2F12.5,2F16.5,4X,I4)                              GE05440
970   FORMAT (1H1//30X,38HERROR - PROGRAM CANNOT PROCESS PTEST =,F5.1,12GE05450
     1H AND QTEST =,F5.1)                                             GE05460
980   FORMAT (//48X,35HBREAK POINTS FOR THIS CONFIGURATION//)          GE05470
990   FORMAT (28X,5HPOINT,6X,1HX,11X,1HY,11X,5HSWEEP,10X,8HDIHEDRAL,7X,4GE05480
     1HMOVE/38X,3HREF,9X,3HREF,10X,5HANGLE,11X,5HANGLE,9X,4HCODE/)     GE05490
1000  FORMAT (/52X,28HSECOND PLANFORM BREAK POINTS/)                   GE05500
1010  FORMAT (////25X,34HTHE BREAKPOINT LOCATED SPANWISE AT,F11.5,3X,20HGE05510
     1HAS BEEN ADJUSTED TO,F9.5////)                                  GE05520
1020  FORMAT (/43X,F5.0,41H HORSESHOE VORTICES IN EACH CHORDWISE ROW)  GE05530
1030  FORMAT (/23X,98HTABLE OF HORSESHOE VORTICES IN EACH CHORDWISE ROW GE05540
     1(FROM TIP TO ROOT BEGINNING WITH FIRST PLANFORM)//25F5.0/25F5.0) GE05550
1040  FORMAT (///33X15,62H HORSESHOE VORTICES USED ON THE LEFT HALF OF TGE05560
     1HE CONFIGURATION//50X,36HPLANFORM       TOTAL        SPANWISE/)  GE05570
1050  FORMAT (52X,I4,10X,I3,11X,I4)                                    GE05580
      END                                                              GE05590-
```

```
      OVERLAY(WINGTL,2,0)                                                MAT  10
      PROGRAM MATXSOL                                                    MAT  20
      DIMENSION YY(2), FV(2), FW(2), FVN(200)                            MAT  30
      COMMON /ALL/ BOT,M,BETA,PTEST,QTEST,TBLSCW(50),Q(200),PN(200),PV(2MAT  40
     100),ALP(200),S(200),PSI(200),PHI(50),ZH(50)                        MAT  50
      COMMON /TOTHRE/ CIR(200,2)                                         MAT  60
      COMMON /INSUB23/ APSI,APHI,XX,YYY,ZZ,SNN,TOLC                      MAT  70
C                                                                        MAT  80
C                                                                        MAT  90
C     PART 2 - COMPUTE CIRCULATION TERMS                                 MAT 100
C                                                                        MAT 110
C                                                                        MAT 120
C     THE TOLERANCE SET AT THIS POINT IN THE PROGRAM MAY NEED TO BE      MAT 130
C     CHANGED FOR COMPUTERS OTHER THAN THE CDC 6000 SERIES               MAT 140
C                                                                        MAT 150
C                                                                        MAT 160
      TOLC=(BOT*15.E-05)**2                                              MAT 170
      DO 10 NV=1,M                                                       MAT 180
      CIR(NV,1)=12.5663704*ALP(NV)                                       MAT 190
      CIR(NV,2)=12.5663704                                               MAT 200
      IF (PTEST.NE.0.) CIR(NV,2)=-1.0964155*Q(NV)/BOT                    MAT 210
      IF (QTEST.NE.0.) CIR(NV,2)=-1.0964155*PV(NV)*BETA                  MAT 220
10    CONTINUE                                                           MAT 230
      IZZ=1                                                              MAT 240
      NNV=TBLSCW(IZZ)                                                    MAT 250
      REWIND 10                                                          MAT 260
      DO 70 NV=1,M                                                       MAT 270
      DO 20 I=1,M                                                        MAT 280
20    FVN(I)=0.                                                          MAT 290
      IZ=1                                                               MAT 300
      NNN=TBLSCW(IZ)                                                     MAT 310
      DO 60 NN=1,M                                                       MAT 320
      APHI=ATAN(PHI(IZ))                                                 MAT 330
      APSI=PSI(NN)                                                       MAT 340
      XX=PV(NV)-PN(NN)                                                   MAT 350
      YY(1)=Q(NV)-Q(NN)                                                  MAT 360
      YY(2)=Q(NV)+Q(NN)                                                  MAT 370
      ZZ=ZH(IZZ)-ZH(IZ)                                                  MAT 380
      SNN=S(NN)                                                          MAT 390
      DO 30 I=1,2                                                        MAT 400
      YYY=YY(I)                                                          MAT 410
      CALL INFSUB (BOT,FV(I),FW(I))                                      MAT 420
      APHI=-APHI                                                         MAT 430
      APSI=-APSI                                                         MAT 440
30    CONTINUE                                                           MAT 450
      IF (PTEST.NE.0.) GO TO 40                                          MAT 460
      FVN(NN)=FW(1)+FW(2)-(FV(1)+FV(2))*PHI(IZZ)                         MAT 470
      GO TO 50                                                           MAT 480
40    FVN(NN)=FW(1)-FW(2)-(FV(1)-FV(2))*PHI(IZZ)                         MAT 490
50    IF (NN.LT.NNN.OR.NN.EQ.M) GO TO 60                                 MAT 500
      IZ=IZ+1                                                            MAT 510
      NNN=NNN+TBLSCW(IZ)                                                 MAT 520
60    CONTINUE                                                           MAT 530
      DUMB=-CIR(NV,1)                                                    MAT 540
      DUMY=-CIR(NV,2)                                                    MAT 550
      WRITE (10) (FVN(I),I=1,M),DUMB,DUMY                               MAT 560
      IF (NV.LT.NNV.OR.NV.EQ.M) GO TO 70                                 MAT 570
      IZZ=IZZ+1                                                          MAT 580
      NNV=NNV+TBLSCW(IZZ)                                                MAT 590
70    CONTINUE                                                           MAT 600
      CALL SSLES0 (M,2)                                                  MAT 610
      RETURN                                                             MAT 620
      END                                                                MAT 630-
```

# APPENDIX C

```
      SUBROUTINE SSLES0 (NT,NCFLG)                                      SSL  10
      COMMON /TOTHRE/ CIR(200,2)                                        SSL  20
      DIMENSION RV(205), CV(205), R(205), V(10350)                      SSL  30
      REWIND 10                                                         SSL  40
      N1=NT*NCFLG                                                       SSL  50
      J=N1-1                                                            SSL  60
      READ (10) (R(I),I=1,N1)                                           SSL  70
      DO 10 I=1,J                                                       SSL  80
10    V(I)=-R(I+1)/R(1)                                                 SSL  90
      IN=1                                                              SSL 100
20    READ (10) (R(I),I=1,N1)                                           SSL 110
      I2=0                                                              SSL 120
      DO 40 I=1,J                                                       SSL 130
      RV(I)=0.                                                          SSL 140
      DO 30 II=1,IN                                                     SSL 150
      I2=I2+1                                                           SSL 160
30    RV(I)=RV(I)+R(II)*V(I2)                                           SSL 170
      N2=I+IN                                                           SSL 180
40    RV(I)=RV(I)+R(N2)                                                 SSL 190
      I2=IN+1                                                           SSL 200
      NN=J*IN+1                                                         SSL 210
      KK=J*I2                                                           SSL 220
      J=J-1                                                             SSL 230
      DO 60 I=1,J                                                       SSL 240
      DO 50 II=1,IN                                                     SSL 250
      NN=NN-1                                                           SSL 260
      KK=KK-1                                                           SSL 270
      V(KK)=V(NN)                                                       SSL 280
50    KK=KK-1                                                           SSL 290
60    DO 70 I=1,IN                                                      SSL 300
      R(I)=V(I)                                                         SSL 310
70    K=0                                                               SSL 320
      DO 90 I=1,J                                                       SSL 330
      CC=-RV(I+1)/RV(1)                                                 SSL 340
      DO 80 II=1,IN                                                     SSL 350
      CV(II)=CC*R(II)                                                   SSL 360
      NN=K+II                                                           SSL 370
      I2=I2+1                                                           SSL 380
80    V(NN)=CV(II)+V(I2)                                                SSL 390
      K=NN+1                                                            SSL 400
      I2=I2+1                                                           SSL 410
90    V(K)=CC                                                           SSL 420
      IN=IN+1                                                           SSL 430
      IF (J.EQ.NCFLG) GO TO 100                                         SSL 440
      GO TO 20                                                          SSL 450
100   K=1                                                               SSL 460
      DO 110 J=1,NCFLG                                                  SSL 470
      DO 110 I=1,NT                                                     SSL 480
      CIR(I,J)=V(K)                                                     SSL 490
      K=K+1                                                             SSL 500
110   CONTINUE                                                          SSL 510
      RETURN                                                            SSL 520
      END                                                               SSL 530
```

# APPENDIX C

```
      OVERLAY(WINGTL,3,0)                                                    AER  10
      PROGRAM AERODYN                                                        AER  20
C                                                                            AER  30
C                                                                            AER  40
      DIMENSION YCP(2), CLCC(200,2), CH(2,50), SUM(2), AC(2), CLCL(2,50)     AER  50
     1, CP(200), P(200), SMOAD(2,50), SLDT(50), SMLO(2,50)                   AER  60
      COMMON /ALL/ BOT,M,BETA,PTEST,QTEST,TBLSCW(50),Q(200),PN(200),PV(2      AER  70
     100),ALP(200),S(200),PSI(200),PHI(50),ZH(50)                            AER  80
      COMMON /TOTHRE/ CIR(200,2)                                             AER  90
      COMMON /THREFOR/ CCAV(2,50),CLT,CLNT,NSSW,ALPD                         AER 100
      COMMON /ONETHRE/ TWIST(2),CREF,SREF,CAVE,CLDES,STRUE,AR,ARTRUE,RTCAER 110
     1DHT(2),CONFIG,NSSWSV(2),MSV(2),KBOT,PLAN,IPLAN,MACH,SSWWA(50),XL(2AER 120
     2),XT(2),CLWB,CMCL,CLA(2),BLAIR(50),CLAMAR(2)                           AER 130
      COMMON /THRECDI/ SLOAD(3,50)                                           AER 140
      COMMON /INSUB23/ APSI,APHI,XX,YYY,ZZ,SNN,TOLCSQ                        AER 150
C                                                                            AER 160
C                                                                            AER 170
C     PART 3 - COMPUTE OUTPUT TERMS                                          AER 180
C                                                                            AER 190
C                                                                            AER 200
      RAD=57.29578                                                           AER 210
      TWST=TWIST(1)+TWIST(2)                                                 AER 220
      ALREF=1                                                                AER 230
      QINF=1.                                                                AER 240
      NSSW=NSSWSV(1)+NSSWSV(2)                                               AER 250
C                                                                            AER 260
C                              PART 3 - SECTION 1                            AER 270
C                    COMPUTE LIFT AND PITCHING MOMENT HERE                   AER 280
C                                                                            AER 290
      IZ=1                                                                   AER 300
      NNN=TBLSCW(IZ)                                                         AER 310
      DO 10 I=1,M                                                            AER 320
      P(I)=S(I)*COS(ATAN(PHI(IZ)))                                           AER 330
      IF (I.LT.NNN.OR.I.EQ.M) GO TO 10                                       AER 340
      IZ=IZ+1                                                                AER 350
      NNN=NNN+TBLSCW(IZ)                                                     AER 360
10    CONTINUE                                                               AER 370
      DO 20 NV=1,2                                                           AER 380
      SUM(NV)=0                                                              AER 390
      DO 20 I=1,M                                                            AER 400
      SUM(NV)=SUM(NV)+CIR(I,NV)*P(I)                                         AER 410
      IF (NV.EQ.1.AND.I.EQ.MSV(1)) CLWNGT=SUM(1)*8./SREF                     AER 420
      IF (NV.EQ.2.AND.I.EQ.MSV(1)) CLWING=SUM(2)*8./SREF                     AER 430
20    CONTINUE                                                               AER 440
      CLT=8.*SUM(1)/SREF                                                     AER 450
      CLNT=8.*SUM(2)/SREF                                                    AER 460
      IF (KBOT.EQ.1) GO TO 30                                                AER 470
      CLWNGT=CLT-CLWNGT                                                      AER 480
      CLWING=CLNT-CLWING                                                     AER 490
30    CRL=0.                                                                 AER 500
      DO 40 I=1,M                                                            AER 510
      CRL=CRL+(Q(I)*CIR(I,2)*2.*P(I))*2.                                     AER 520
      CLCC(I,1)=CIR(I,1)*2*P(I)/(CAVE*S(I))                                  AER 530
40    CLCC(I,2)=CIR(I,2)*2*P(I)/(CAVE*S(I))                                  AER 540
C                                                                            AER 550
C     COMPUTE CLP                                                            AER 560
C                                                                            AER 570
      CLP=CRL/(SREF*BOT*0.08725)                                             AER 580
      CLA(2)=CLNT                                                            AER 590
      DO 120 IXX=1,2                                                         AER 600
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```
      SA=SB=SC=0.                                                        AER 610
      I=0                                                                AER 620
      JB=NSSWSV(1)                                                       AER 630
      JA=1                                                               AER 640
50    CONTINUE                                                           AER 650
      DO 70 JSSW=JA,JB                                                   AER 660
      SD=SE=0.                                                           AER 670
      SLOAD(IXX,JSSW)=0                                                  AER 680
      NSCW=TBLSCW(JSSW)                                                  AER 690
      DO 70 JSCW=1,NSCW                                                  AER 700
      IF (TWST.EQ.0..AND.IXX.EQ.1) GO TO 60                              AER 710
      I=I+1                                                              AER 720
      SA=SA+CIR(I,IXX)*P(I)                                              AER 730
      SB=SB+CIR(I,IXX)*Q(I)*P(I)                                         AER 740
      SC=SC+CIR(I,IXX)*PN(I)*P(I)*BETA                                   AER 750
      SLOAD(IXX,JSSW)=SLOAD(IXX,JSSW)+(BOT*CIR(I,IXX)*P(I)/S(I))/(2.*SUMAER 760
     1(IXX))                                                             AER 770
      SD=SD+CIR(I,IXX)                                                   AER 780
      SE=SE+CIR(I,IXX)*PN(I)*BETA                                        AER 790
      IF (JSCW.NE.NSCW) GO TO 70                                         AER 800
      SMOAD(IXX,JSSW)=SE                                                 AER 810
      SMLD(IXX,JSSW)=SD                                                  AER 820
      GO TO 70                                                           AER 830
60    SLOAD(1,JSSW)=SMOAD(1,JSSW)=SMLD(1,JSSW)=0.                        AER 840
70    CONTINUE                                                           AER 850
      IF (JSSW.GE.NSSW) GO TO 80                                         AER 860
      JA=NSSWSV(1)+1                                                     AER 870
      JB=NSSW                                                            AER 880
      IF (IXX.EQ.1) GO TO 50                                             AER 890
      SC2=SC                                                             AER 900
      SA2=SA                                                             AER 910
      CLAMAR(1)=SC/(SA*CREF)                                             AER 920
      GO TO 50                                                           AER 930
80    CONTINUE                                                           AER 940
      IF (IXX.EQ.1) GO TO 100                                            AER 950
      IF (IPLAN.EQ.1) GO TO 90                                           AER 960
      SC3=SC-SC2                                                         AER 970
      SA3=SA-SA2                                                         AER 980
      CLAMAR(2)=SC3/(SA3*CREF)                                           AER 990
      GO TO 100                                                          AER1000
90    CLAMAR(1)=SC/(SA*CREF)                                             AER1010
100   CONTINUE                                                           AER1020
      IF (TWST.EQ.0..AND.IXX.EQ.1) GO TO 110                             AER1030
      YCP(IXX)=SB/(SA*BOT)                                               AER1040
      AC(IXX)=SC/(SA*CREF)                                               AER1050
      GO TO 120                                                          AER1060
110   YCP(1)=AC(1)=0.                                                    AER1070
120   CONTINUE                                                           AER1080
      CMCL=AC(2)                                                         AER1090
      CMO=(AC(1)-AC(2))*CLT                                              AER1100
C                                                                        AER1110
C                              PART 3 - SECTION 2                        AER1120
C            COMPUTE OTHER-  AND PRINT ALL FINAL-  OUTPUT DATA HERE      AER1130
C                                                                        AER1140
      DO 140 IXX=1,2                                                     AER1150
      JN=0                                                               AER1160
      DO 140 JSSW=1,NSSW                                                 AER1170
      CH(IXX,JSSW)=0                                                     AER1180
      NSCW=TBLSCW(JSSW)                                                  AER1190
      DO 130 JSCW=1,NSCW                                                 AER1200
```

```
      JN=JN+1                                                                AER1210
      CH(IXX,JSSW)=(-2.0)*(PV(JN)-PN(JN))*BETA+CH(IXX,JSSW)                  AER1220
  130 CONTINUE                                                               AER1230
      CCAV(IXX,JSSW)=CH(IXX,JSSW)/CAVE                                       AER1240
      CLCL(IXX,JSSW)=SLOAD(IXX,JSSW)/CCAV(IXX,JSSW)                          AER1250
  140 CONTINUE                                                               AER1260
      CLD=CLDES                                                              AER1270
      IF (CLDES.EQ.11) CLD=1.                                                AER1280
      DO 150 I=1,M                                                           AER1290
      CP(I)=(CLCC(I,1)+CLCC(I,2)*(CLD-CLT)/CLNT)*CAVE/(2.*(PN(I)-PV(I))*BAER1300
     1ETA)                                                                   AER1310
  150 CONTINUE                                                               AER1320
      WRITE (6,240) CONFIG                                                   AER1330
      IF (PTEST.NE.0.) WRITE (6,350)                                         AER1340
      IF (QTEST.NE.0.) WRITE (6,330)                                         AER1350
      IF (PTEST.EQ.0..AND.QTEST.EQ.0.) WRITE (6,340)                         AER1360
      WRITE (6,360) CLD                                                      AER1370
      HEAD=8HDESIRED                                                         AER1380
      IF (CLDES.EQ.11.) HEAD=8H                                              AER1390
      IEND=11                                                                AER1400
      IF (CLDES.NE.11.) IEND=1                                               AER1410
      DO 190 IUTK=1,IEND                                                     AER1420
      IF (IEND.EQ.11) CLDES=(FLOAT(IUTK)-1.)/10.                             AER1430
      IF (CLDES.EQ.0.) CLDES=-.1                                             AER1440
      NR=0                                                                   AER1450
      DO 160 NV=1,NSSW                                                       AER1460
      NSCW=TBLSCW(NV)                                                        AER1470
      NP=NR+1                                                                AER1480
      NR=NR+NSCW                                                             AER1490
      PHIPR=ATAN(PHI(NV))*RAD                                                AER1500
      SLOAD(3,NV)=0.                                                         AER1510
      IF (NV.EQ.(NSSWSV(1)+1).AND.IEND.EQ.1) WRITE (6,230)                   AER1520
      DO 160 I=NP,NR                                                         AER1530
      IF (IUTK.GT.1) GO TO 160                                               AER1540
      PNPR=PN(I)*BETA                                                        AER1550
      PVPR=PV(I)*BETA                                                        AER1560
      PSIPR=ATAN(BETA*TAN(PSI(I)))*RAD                                       AER1570
      WRITE (6,370) PNPR,PVPR,Q(I),ZH(NV),S(I),PSIPR,PHIPR,ALP(I),CP(I)      AER1580
  160 SLOAD(3,NV)=SLOAD(3,NV)+CLCC(I,2)*CLDES/CLNT+CLCC(I,1)-CLCC(I,2)*CAER1590
     1LT/CLNT                                                                AER1600
      IF (IUTK.GT.1) GO TO 170                                               AER1610
      WRITE (6,270)                                                          AER1620
      WRITE (6,280) CREF,CAVE,STRUE,SREF,BOT,AR,ARTRUE,MACH                  AER1630
  170 CONTINUE                                                               AER1640
C                                                                            AER1650
C                                                                            AER1660
      IF (PTEST.NE.0.) WRITE (6,380) CLP                                     AER1670
      IF (PTEST.NE.0.) GO TO 220                                             AER1680
C                                                                            AER1690
C     COMPUTE CMQ,CLQ                                                        AER1700
C                                                                            AER1710
      CMQ=2.0*CMCL*CLNT/(0.08725*CREF)                                       AER1720
      CLQ=2.0*CLNT/(0.08725*CREF)                                            AER1730
      IF (QTEST.NE.0.) WRITE (6,390) CMQ,CLQ                                 AER1740
      IF (QTEST.NE.0.) GO TO 220                                             AER1750
C                                                                            AER1760
C        COMPUTE INDUCED DRAG FOR FLAT WING-BODY WITH NO DIHEDRAL            AER1770
C                                                                            AER1780
      NSV=NSSWSV(1)+1                                                        AER1790
      MTOT=MSV(1)+1                                                          AER1800
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```
      IF (KBOT.EQ.1) GO TO 180                                          AER1810
      NSV=NSV+NSSWSV(2)                                                 AER1820
      MTOT=MTOT+MSV(2)                                                  AER1830
180   CALL CDICLS (AR,ARTRUE,NSSWSV(KBOT),MTOT,NSV,CDI,CDIT)           AER1840
      CLAPD=CLA(2)/57.29578                                             AER1850
      ALPO=-(CLT/CLA(2))*57.29578                                       AER1860
      ALPD=CLDES/CLAPD+ALPO                                             AER1870
      ALPW=1./CLAPD                                                     AER1880
      CLWB=CLWING*ALPD/57.29578+CLWNGT                                  AER1890
      CDIWB=CDI/(CLWB*CLWB)                                             AER1900
      IF (IUTK.EQ.1) WRITE (6,250) HEAD,CDIT                            AER1910
190   WRITE (6,260) CLDES,ALPD,CLWB,CDI,CDIWB                           AER1920
      WRITE (6,290) CLA(2),CLAPD,CLT,ALPO,YCP(2),CMCL,CMO               AER1930
      WRITE (6,300) CLT                                                 AER1940
      NR=J=0                                                            AER1950
      DO 210 NV=1,NSSW                                                  AER1960
      BCLCC=BADLAE=BASLD=0.                                             AER1970
      NSCW=TBLSCW(NV)                                                   AER1980
      NP=NR+1                                                           AER1990
      NR=NR+NSCW                                                        AER2000
      DO 200 I=NP,NR                                                    AER2010
      ADLAE=CLCC(I,2)*CLT/CLNT                                          AER2020
      BSLD=CLCC(I,1)-ADLAE                                              AER2030
      BCLCC=BCLCC+CLCC(I,1)                                             AER2040
      BADLAE=BADLAE+ADLAE                                               AER2050
      BASLD=BASLD+BSLD                                                  AER2060
200   CONTINUE                                                          AER2070
      SLDT(NV)=(SMOAD(1,NV)+SMOAD(2,NV)*(CLDES-CLT)/CLNT)/(SMLD(1,NV)+SMAER2080
     1LD(2,NV)*(CLDES-CLT)/CLNT)                                        AER2090
      J=J+NSCW                                                          AER2100
      YQ=Q(J)/BOT                                                       AER2110
      IF (NV.EQ.(NSSWSV(1)+1)) WRITE (6,310)                            AER2120
210   WRITE (6,320) NV,YQ,SLOAD(2,NV),CLCL(2,NV),CCAV(2,NV),BCLCC,BADLAEAER2130
     1,BASLD,SLOAD(3,NV),SLDT(NV)                                       AER2140
220   CONTINUE                                                          AER2150
      RETURN                                                            AER2160
C                                                                       AER2170
C                                                                       AER2180
C                                                                       AER2190
230   FORMAT (/12X,45HSECOND PLANFORM HORSESHOE VORTEX DESCRIPTIONS/)    AER2200
240   FORMAT (1H1///58X,16HAERODYNAMIC DATA///54X,17HCONFIGURATION NO.,FAER2210
     17.0//)                                                            AER2220
250   FORMAT (1H1,18X,22HCOMPLETE CONFIGURATION,31X,25HWING-BODY CHARACTAER2230
     1ERISTICS/64X,4HLIFT,9X,33HINDUCED DRAG (FAR FIELD SOLUTION)//16XA8AER2240
     2,21H CL    COMPUTED ALPHA,19X,6HCL(WB),7X,13HCDI AT CL(WB),4X,15HCAER2250
     3DI/(CL(WB)**2)/88X,12H(1/(PI*AR) =F8.5,2H ))                      AER2260
260   FORMAT (11X,2F15.5,15X,3F15.5)                                    AER2270
270   FORMAT (////4X,11H REF. CHORD,6X,25HC AVERAGE     TRUE AREA  ,2X,1AER2280
     14HREFERENCE AREA,9X,3HB/2,8X,7HREF. AR,8X,7HTRUE AR,4X,11HMACH NUMAER2290
     28ER/)                                                             AER2300
280   FORMAT (8F15.5)                                                   AER2310
290   FORMAT (///47X,38HCOMPLETE CONFIGURATION CHARACTERISTICS//36X,8HCLAER2320
     1 ALPHA,8X,53HCL(TWIST)  ALPHA AT CL=0    Y CP       CM/CL        CMOAER2330
     2/27X,23HPER RADIAN   PER DEGREE/24X,7F12.5)                       AER2340
300   FORMAT (//25X,18HADDITIONAL LOADING/24X,24HWITH CL BASED ON S(TRUEAER2350
     1)71X,11H-AT CL DES-/67X,34HLOAD DUE  ADD. LOAD AT  BASIC LOAD3X,27AER2360
     2HSPAN LOAD AT   X LOCATON OF/8H STATION6X,5H 2Y/B9X,9H SL COEF ,4XAER2370
     3,8HCL RATIO4X,7HC RATIO,7X,14HTO TWIST   CL=,F9.5,3X,7HAT CL=05X,2AER2380
     46HDESIRED CL   LOCAL CENT PR/)                                    AER2390
310   FORMAT (/47X,61HCONTRIBUTION OF THE SECOND PLANFORM TO SPAN LOAD DAER2400
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     1ISTRIBUTION/)                                                          AER2410
320   FORMAT (4X,I4,F12.5,5X,3F12.5,3X,3F12.5,3X,2F12.5)                     AER2420
330   FORMAT (/54X,24HCMQ AND CLQ ARE COMPUTED//)                            AER2430
340   FORMAT (/38X,57HSTATIC LONGITUDINAL AERODYNAMIC COEFFICIENTS ARE CAER2440
     1OMPUTED//)                                                            AER2450
350   FORMAT (/59X,15HCLP IS COMPUTED//)                                     AER2460
360   FORMAT (/20X,1HX,11X,1HX,11X,1HY,11X,1HZ,12X,1HS,5X,9HC/4 SWEEP,4XAER2470
     1,8HDIHEDRAL,2X,11HLOCAL ALPHA,2X,19HDELTA CP AT DESIRED/19X,3HC/4,AER2480
     29X,4H3C/4,42X,5HANGLE,7X,5HANGLE,4X,10HIN RADIANS,4X,4HCL =,F10.5/AER2490
     3)                                                                     AER2500
370   FORMAT (12X,9F12.5)                                                    AER2510
380   FORMAT (//////////56X,4HCLP=,F9.5////)                                 AER2520
390   FORMAT (//////////42X,4HCMQ=,F9.5,10X,4HCLQ=,F9.5////)                 AER2530
      END                                                                   AER2540-
```

# APPENDIX C

```
      SUBROUTINE FTLUP (X,Y,M,N,VARI,VARD)                                  TLU  10
C     ***DOCUMENT DATE 09-12-69    SUBROUTINE REVISED 07-07-69 *********TLU  20
C        MODIFICATION OF LIBRARY INTERPOLATION SUBROUTINE  FTLUP            TLU  30
      DIMENSION VARI(1), VARD(1), V(3), YY(2)                               TLU  40
      DIMENSION II(43)                                                      TLU  50
C                                                                           TLU  60
C      INITIALIZE ALL INTERVAL POINTERS TO -1.0   FOR MONOTONICITY CHECKTLU  70
      DATA (II(J),J=1,43)/43*-1/                                            TLU  80
      MA=IABS(M)                                                            TLU  90
C                                                                           TLU 100
C            ASSIGN INTERVAL POINTER FOR GIVEN VARI TABLE                   TLU 110
C      THE SAME POINTER WILL BE USED ON A GIVEN VARI TABLE EVERY TIME       TLU 120
      LI=MOD(LOCF(VARI(1)),43)+1                                            TLU 130
      I=II(LI)                                                              TLU 140
      IF (I.GE.0) GO TO 60                                                  TLU 150
      IF (N.LT.2) GO TO 60                                                  TLU 160
C                                                                           TLU 170
C     MONOTONICITY CHECK                                                    TLU 180
      IF (VARI(2)-VARI(1)) 20,20,40                                         TLU 190
C     ERROR IN MONOTONICITY                                                 TLU 200
10    K=LOCF(VARI(1))                                                       TLU 210
      PRINT 170, J,K,(VARI(J),J=1,N),(VARD(J),J=1,N)                        TLU 220
      STOP                                                                  TLU 230
C     MONOTONIC DECREASING                                                  TLU 240
20    DO 30 J=2,N                                                           TLU 250
      IF (VARI(J)-VARI(J-1)) 30,10,10                                       TLU 260
30    CONTINUE                                                              TLU 270
      GO TO 60                                                              TLU 280
C     MONOTONIC INCREASING                                                  TLU 290
40    DO 50 J=2,N                                                           TLU 300
      IF (VARI(J)-VARI(J-1)) 10,10,50                                       TLU 310
50    CONTINUE                                                              TLU 320
C                                                                           TLU 330
C     INTERPOLATION                                                         TLU 340
60    IF (I.LE.0) I=1                                                       TLU 350
      IF (I.GE.N) I=N-1                                                     TLU 360
      IF (N.LE.1) GO TO 70                                                  TLU 370
      IF (MA.NE.0) GO TO 80                                                 TLU 380
C     ZERO ORDER                                                            TLU 390
70    Y=VARD(1)                                                             TLU 400
      GO TO 160                                                             TLU 410
C     LOCATE I INTERVAL (X(I).LE.X.LT.X(I+1))                               TLU 420
80    IF ((VARI(I)-X)*(VARI(I+1)-X)) 110,110,90                             TLU 430
C     IN GIVES DIRECTION FOR SEARCH OF INTERVALS                            TLU 440
90    IN=SIGN(1.0,(VARI(I+1)-VARI(I))*(X-VARI(I)))                          TLU 450
C     IF X OUTSIDE ENDPOINTS, EXTRAPOLATE FROM END INTERVAL                 TLU 460
100   IF ((I+IN).LE.0) GO TO 110                                            TLU 470
      IF ((I+IN).GE.N) GO TO 110                                            TLU 480
      I=I+IN                                                                TLU 490
      IF ((VARI(I)-X)*(VARI(I+1)-X)) 110,110,100                            TLU 500
110   IF (MA.EQ.2) GO TO 120                                                TLU 510
C                                                                           TLU 520
C     FIRST ORDER                                                           TLU 530
      Y=(VARD(I)*(VARI(I+1)-X)-VARD(I+1)*(VARI(I)-X))/(VARI(I+1)-VARI(I)TLU 540
     1)                                                                     TLU 550
      GO TO 160                                                             TLU 560
C                                                                           TLU 570
C     SECOND ORDER                                                          TLU 580
120   IF (N.EQ.2) GO TO 10                                                  TLU 590
      IF (I.EQ.(N-1)) GO TO 140                                             TLU 600
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```
      IF (I.EQ.1) GO TO 130                                                    TLU 610
C     PICK THIRD POINT                                                         TLU 620
      SK=VARI(I+1)-VARI(I)                                                     TLU 630
      IF ((SK*(X-VARI(I-1))).LT.(SK*(VARI(I+2)-X))) GO TO 140                  TLU 640
130   L=I                                                                      TLU 650
      GO TO 150                                                                TLU 660
140   L=I-1                                                                    TLU 670
150   V(1)=VARI(L)-X                                                           TLU 680
      V(2)=VARI(L+1)-X                                                         TLU 690
      V(3)=VARI(L+2)-X                                                         TLU 700
      YY(1)=(VARD(L)*V(2)-VARD(L+1)*V(1))/(VARI(L+1)-VARI(L))                  TLU 710
      YY(2)=(VARD(L+1)*V(3)-VARD(L+2)*V(2))/(VARI(L+2)-VARI(L+1))              TLU 720
      Y=(YY(1)*V(3)-YY(2)*V(1))/(VARI(L+2)-VARI(L))                            TLU 730
160   II(LI)=I                                                                 TLU 740
      RETURN                                                                   TLU 750
C                                                                              TLU 760
C                                                                              TLU 770
170   FORMAT (1H1,50H TABLE BELOW OUT OF ORDER FOR FTLUP  AT POSITION  ,TLU 780
     1I5,/31H X TABLE IS STORED IN LOCATION ,06,//(8G15.8))                    TLU 790
      END                                                                      TLU 800-
```

```
      SUBROUTINE CDICLS (AR,ARTRUE,ISEMSP,MTOT,NSV,CDI,CDIT)                CDI  10
      DIMENSION ETAN(51), GAMPR(51,1), ETA(41), GAMMA(41), VE(41), B(41)CDI  20
     1, FVN(41,41)                                                          CDI  30
      COMMON /ALL/ BOT,M,BETA,PTEST,QTEST,TBLSCW(50),Q(200),PN(200),PV(2CDI  40
     100),ALP(200),S(200),PSI(200),PHI(50),ZH(50)                           CDI  50
      COMMON /THRECDI/ SLOAD(3,50)                                          CDI  60
      DO 10 I=1,41                                                          CDI  70
      DO 10 J=1,41                                                          CDI  80
10    FVN(I,J)=0                                                            CDI  90
      SPAN=2.*BOT                                                           CDI 100
      CAVB=SPAN/ARTRUE                                                      CDI 110
      PI=.31415926 5E+01                                                    CDI 120
      NST=ISEMSP+1                                                          CDI 130
      NN=MTOT                                                               CDI 140
      DO 20 N=1,ISEMSP                                                      CDI 150
      NM=NSV-N                                                              CDI 160
      NSCW=TBLSCW(NM)                                                       CDI 170
      NN=NN-NSCW                                                            CDI 180
      ETAN(N)=ASIN(-Q(NN)*2./SPAN)                                          CDI 190
      GAMPR(N,1)=SLOAD(3,NM)*CAVB/(2.*SPAN)                                 CDI 200
20    CONTINUE                                                              CDI 210
      ETAN(NST)=PI/2.                                                       CDI 220
      GAMPR(NST,1)=0                                                        CDI 230
      DO 30 NP=1,41                                                         CDI 240
      ANP=NP                                                                CDI 250
30    ETA(NP)=(ANP-21.)*PI/42.                                              CDI 260
C                                                                           CDI 270
      DO 40 JK=21,41                                                        CDI 280
      CALL FTLUP (ETA(JK),GAMMA(JK),1,NST,ETAN,GAMPR)                       CDI 290
40    CONTINUE                                                              CDI 300
      DO 50 NY=22,41                                                        CDI 310
      ETA(NY)=SIN(ETA(NY))                                                  CDI 320
      NR=42-NY                                                              CDI 330
      ETA(NR)=-ETA(NY)                                                      CDI 340
50    GAMMA(NR)=GAMMA(NY)                                                   CDI 350
      DO 90 NU=21,41                                                        CDI 360
      ANU=NU                                                                CDI 370
      DO 80 N=1,41                                                          CDI 380
      AN=N                                                                  CDI 390
      NNUD=IABS(N-NU)                                                       CDI 400
      VE(N)=COS(((AN-21.)*PI)/42.)                                          CDI 410
      IF (NNUD.NE.0) GO TO 60                                               CDI 420
      B(N)=(42.)/(4.0*COS(((ANU-21.)*PI)/42.))                              CDI 430
      GO TO 80                                                              CDI 440
60    IF (MOD(NNUD,2).EQ.0) GO TO 70                                        CDI 450
      B(N)=VE(N)/((42.)*(ETA(N)-ETA(NU))**2)                                CDI 460
      GO TO 80                                                              CDI 470
70    B(N)=0.0                                                              CDI 480
80    CONTINUE                                                              CDI 490
      DO 90 NP=21,41                                                        CDI 500
      NUST=IABS(NU-21)                                                      CDI 510
      IF (NUST.EQ.0) GO TO 90                                               CDI 520
      IF (MOD(NUST,2).EQ.0) GO TO 90                                        CDI 530
      NPST=IABS(NP-20)                                                      CDI 540
      IF (MOD(NPST,2).EQ.0) GO TO 90                                        CDI 550
      NPNUD=IABS(NP-NU)                                                     CDI 560
      IF (NPNUD.EQ.0) GO TO 90                                              CDI 570
      IF (MOD(NPNUD,2).EQ.0) GO TO 90                                       CDI 580
      FVN(NU,NP)=2.0*B(NP)/21.*COS((ANU-21.)*PI/42.)                        CDI 590
      IT=42-NU                                                              CDI 600
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```
      ITT=42-NP                                                          CDI 610
      FVN(NU,ITT)=2.0*B(ITT)/21.*COS((ANU-21.)*PI/42.)                   CDI 620
      FVN(IT,NP)=FVN(NU,ITT)                                             CDI 630
      FVN(IT,ITT)=FVN(NU,NP)                                             CDI 640
90    CONTINUE                                                           CDI 650
C                                                                        CDI 660
      CCC=0.0                                                            CDI 670
      DO 100 N=1,41                                                      CDI 680
100   CCC=CCC+(GAMMA(N)*GAMMA(N))                                        CDI 690
      DO 110 NUP=1,41                                                    CDI 710
      DO 110 N=1,41                                                      CDI 720
      CCD=CCD-2.0*FVN(NUP,N)*(GAMMA(NUP)*GAMMA(N))                       CDI 730
110   CONTINUE                                                           CDI 740
      CDI=PI*AR/4.*(CCC+CCD)                                             CDI 750
      CDIT=1./(PI*AR)                                                    CDI 760
      RETURN                                                             CDI 770
      END                                                                CDI 780-
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      OVERLAY(WINGTL,4,0)                                                    DRA  10
      PROGRAM CDRAGNF                                                        DRA  20
      DIMENSION GAM(1000), XC4(1000), YQ(1000), CCR(20), FW(2), FV(2), XDRA  30
     1XCC(20), CCC(200), CRR(200), YB(50), CRI(51), NMA(2), XCC4(200), CDRA  40
     2HD(50), XC44(50), YY(2), PPHI(50), ZZH(50), Z(1000), PHII(1000), SDRA  50
     3A(50), SSA(1000), ALOP(200), ALLP(50), ALPPD(1000), ALO(20), YC(51DRA  60
     4), YQQ(50)                                                            DRA  70
      COMMON /ALL/ BOT,M,BETA,PTEST,QTEST,TBLSCW(50),Q(200),PN(200),PV(2DRA  80
     100),ALP(200),S(200),PSI(200),PHI(50),ZH(50)                           DRA  90
      COMMON /ONETHRE/ TWIST(2),CREF,SREF,CAVE,CLDES,STRUE,AR,ARTRUE,RTCDRA 100
     1DHT(2),CONFIG,NSSWSV(2),MSV(2),KBOT,PLAN,IPLAN,MACH,SSWWA(50),XL(2DRA 110
     2),XT(2),CLWB,CMCL,CLA(2),BLAIR(50),CLAMAR(2)                          DRA 120
      COMMON /TOTHRE/ CIR(200,2)                                            DRA 130
      COMMON /INSUB23/ APSI,APHI,XX,YYY,ZZ,SNN,TOLCSQ                       DRA 140
      COMMON /THREFOR/ CCAV(2,50),CLT,CLNT,NSSW,ALPD                        DRA 150
      COMMON /CCRRDD/ TSPAN,TSPANA,KBIT                                     DRA 160
C                                                                           DRA 170
C                                                                           DRA 180
      WRITE (6,250)                                                         DRA 190
      APSI=TOLCSQ=TBLS=0.                                                   DRA 200
      PI=4.*ATAN(1.)                                                        DRA 210
      FPI=4.*PI                                                             DRA 220
      BOTL=ABS(TSPAN)                                                       DRA 230
      BOL=ABS(TSPANA)                                                       DRA 240
      SNN=BOTL/(2.*NSSWSV(KBOT))                                            DRA 250
      DELTYB=2.*SNN                                                         DRA 260
      NMA(KBOT)=BOTL/DELTYB                                                 DRA 270
      NMA(KBIT)=BOL/DELTYB                                                  DRA 280
      NMAX=NMA(1)+NMA(2)                                                    DRA 290
      DO 10 I=1,M                                                           DRA 300
      CRR(I)=CIR(I,1)+CIR(I,2)*(CLDES-CLT)/CLNT                             DRA 310
10    CONTINUE                                                              DRA 320
      SCWMIN=20.                                                            DRA 330
      DO 20 I=1,NSSW                                                        DRA 340
20    SCWMIN=AMIN1(SCWMIN,TBLSCW(I))                                        DRA 350
      NSCWMIN=SCWMIN                                                        DRA 360
      MM=NSCWMIN*NMAX                                                       DRA 370
      DELTXOC=1./SCWMIN                                                     DRA 380
      DO 100 LA=1,NSSW                                                      DRA 390
      CHD(LA)=CCAV(2,LA)*CAVE/BETA                                          DRA 400
      DELTXX=1./TBLSCW(LA)                                                  DRA 410
      XC=-.75*DELTXX                                                        DRA 420
      ITBL=TBLSCW(LA)                                                       DRA 430
      DO 30 LB=1,ITBL                                                       DRA 440
      XC=XC+DELTXX                                                          DRA 450
      XXCC(LB)=XC                                                           DRA 460
      LC=LB+TBLS                                                            DRA 470
30    ALO(LB)=ALP(LC)                                                       DRA 480
      XLE=PN(LC)+CHD(LA)*(1.-.75/TBLSCW(LA))                                DRA 490
      XOC=-.75*DELTXOC                                                      DRA 500
      KCODE=LB=0                                                            DRA 510
      DO 90 K=1,NSCWMIN                                                     DRA 520
      J=K+(LA-1)*NSCWMIN                                                    DRA 530
      XOC=XOC+DELTXOC                                                       DRA 540
      XCC4(J)=-XOC*CHD(LA)+XLE                                              DRA 550
      CALL FTLUP (XOC,ALOP(J),+1,ITBL,XXCC,ALO)                             DRA 560
      AXMN=K*DELTXOC                                                        DRA 570
      CAT=0.                                                                DRA 580
      IF (KCODE.EQ.2) CAT=CCR(LB)-CUT                                       DRA 590
      KCODE=0                                                               DRA 600
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40      LB=LB+1                                                          DRA 610
        LC=LB+TBLS                                                       DRA 620
        CCR(LB)=CRR(LC)                                                  DRA 630
        AXITBL=LB*DELTXX                                                 DRA 640
        IF (AXMN-AXITBL) 50,60,70                                        DRA 650
50      CUT=CCR(LB)*(AXMN-(LB-1)*DELTXX)/DELTXX                          DRA 660
        KCODE=2                                                          DRA 670
        GO TO 80                                                         DRA 680
60      KCODE=1                                                          DRA 690
70      CUT=CCR(LB)                                                      DRA 700
80      CAT=CAT+CUT                                                      DRA 710
        IF (KCODE.GE.1) GO TO 90                                         DRA 720
        IF (LB.LT.ITBL) GO TO 40                                         DRA 730
90      CCC(J)=CAT                                                       DRA 740
        TBLS=TBLS+TBLSCW(LA)                                             DRA 750
100     CONTINUE                                                         DRA 760
        II=1                                                             DRA 770
        DO 150 I=1,IPLAN                                                 DRA 780
        BOTT=BOTL                                                        DRA 790
        IF (I.EQ.KBIT) BOTT=BOL                                          DRA 800
        IUZ=NSSWSV(I)                                                    DRA 810
        IUX=IUZ+1                                                        DRA 820
        IC=MSV(1)+(I-1)*MSV(2)                                           DRA 830
        ID=IC+1                                                          DRA 840
        IZ=NSSWSV(1)+(I-1)*NSSWSV(2)                                     DRA 850
        YCAT=0.                                                          DRA 860
        IAMM=NMA(I)                                                      DRA 870
        DO 140 LA=1,NSCWMIN                                              DRA 880
        YC(1)=-PI/2.                                                     DRA 890
        CRI(1)=0.                                                        DRA 900
        DO 120 J=1,IUZ                                                   DRA 910
        L=J+1                                                            DRA 920
        LU=LA+(J-1+(I-1)*NSSWSV(1))*NSCWMIN                              DRA 930
        ALLP(J)=ALOP(LU)                                                 DRA 940
        XC44(J)=XCC4(LU)                                                 DRA 950
        CRI(L)=CCC(LU)                                                   DRA 960
        IF (LA.NE.1) GO TO 120                                           DRA 970
        JJ=J+(I-1)*NSSWSV(1)                                             DRA 980
        ZZH(J)=ZH(JJ)                                                    DRA 990
        SA(J)=SSWWA(JJ)                                                  DRA1000
        PPHI(J)=PHI(JJ)                                                  DRA1010
        YQQ(J)=Q(II)                                                     DRA1020
        II=II+TBLSCW(JJ)                                                 DRA1030
        IE=IUZ-J+1                                                       DRA1040
        ITL=TBLSCW(IZ)                                                   DRA1050
        ID=ID-ITL                                                        DRA1060
        IA=ID+ITL                                                        DRA1070
        IF (IA.GT.IC) YCAT=YCAT-S(ID)                                    DRA1080
        IF (IA.GT.IC) GO TO 110                                          DRA1090
        YCAT=YCAT-S(ID)-S(IA)                                            DRA1100
110     IZ=IZ-1                                                          DRA1110
        YB(IE)=YCAT                                                      DRA1120
120     CONTINUE                                                         DRA1130
        DO 130 JP=1,IUZ                                                  DRA1140
        JZ=JP+1                                                          DRA1150
        YC(JZ)=ASIN(YB(JP)/BOTT)                                         DRA1160
130     CONTINUE                                                         DRA1170
        YOB=-NMA(I)*2.*SNN-SNN                                           DRA1180
        DO 140 K=1,IAMM                                                  DRA1190
        KP=LA+(K-1+(I-1)*NMA(1))*NSCWMIN                                 DRA1200
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      YOB=YOB+DELTYB                                                    DRA1210
      YOC=ASIN(YOB/BOTT)                                                DRA1220
      CALL FTLUP (YOB,YQ(KP),+1,IUZ,YB,YQQ)                             DRA1230
      CALL FTLUP (YOB,ALPPD(KP),+1,IUZ,YB,ALLP)                         DRA1240
      CALL FTLUP (YOB,SSA(KP),+1,IUZ,YB,SA)                             DRA1250
      CALL FTLUP (YOB,XC4(KP),+1,IUZ,YB,XC44)                           DRA1260
      CALL FTLUP (YOB,Z(KP),+1,IUZ,YB,ZZH)                              DRA1270
      CALL FTLUP (YOB,PHII(KP),+1,IUZ,YB,PPHI)                          DRA1280
      CALL FTLUP (YOC,GAM(KP),+1,IUX,YC,CRI)                            DRA1290
      IF (YOB.GT.YB(IUZ)) GAM(KP)=CRI(IUX)                              DRA1300
  140 CONTINUE                                                          DRA1310
  150 CONTINUE                                                          DRA1320
      CDRAG=CTHRUST=CSUCT=0.                                            DRA1330
      CONST=16.*SNN*BOT/SREF                                            DRA1340
      DO 190 LI=1,NMAX                                                  DRA1350
      LA=(LI-1)*NSCWMIN+1                                               DRA1360
      LB=LI*NSCWMIN                                                     DRA1370
      CDRAGIT=CTT=0.                                                    DRA1380
      DO 180 NV=LA,LB                                                   DRA1390
      CPT=COS(ATAN(PHII(NV)))                                           DRA1400
      VELIN=0.                                                          DRA1410
      DO 170 NN=1,MM                                                    DRA1420
      XX=XC4(NV)-XC4(NN)                                                DRA1430
      YY(1)=YQ(NV)-YQ(NN)                                               DRA1440
      YY(2)=YQ(NV)+YQ(NN)                                               DRA1450
      ZZ=Z(NV)-Z(NN)                                                    DRA1460
      APHI=ATAN(PHII(NN))                                               DRA1470
      DO 160 I=1,2                                                      DRA1480
      YYY=YY(I)                                                         DRA1490
      CALL INFSUB (BOT,FV(I),FW(I))                                     DRA1500
      APHI=-APHI                                                        DRA1510
  160 CONTINUE                                                          DRA1520
      VELIN=((FW(1)+FW(2))-(FV(1)+FV(2))*PHII(NV))*GAM(NN)/FPI+VELIN    DRA1530
  170 CONTINUE                                                          DRA1540
      CTT=CTT+GAM(NV)*(ALPD/57.29578+ALPPD(NV))*CPT/(2.*BOT)            DRA1550
  180 CDRAGIT=CDRAGIT+VELIN*GAM(NV)*CPT/(2.*BOT)                        DRA1560
      CTT=CTT-CDRAGIT                                                   DRA1570
      SWLE=ATAN(SSA(LA))                                                DRA1580
      CST=CTT/COS(SWLE)                                                 DRA1590
      CCC(LI)=CDRAGIT                                                   DRA1600
      CRR(LI)=CTT                                                       DRA1610
      XCC4(LI)=CST                                                      DRA1620
      CDRAG=CDRAG+CDRAGIT*CONST                                         DRA1630
      CTHRUST=CTHRUST+CTT*CONST                                         DRA1640
      CSUCT=CSUCT+CST*CONST                                             DRA1650
  190 CONTINUE                                                          DRA1660
      TBLE=II=0                                                         DRA1670
      LI=0                                                              DRA1680
      LBLR=0                                                            DRA1690
      DO 220 I=1,2                                                      DRA1700
      IAMM=NMA(I)                                                       DRA1710
      DO 200 J=1,IAMM                                                   DRA1720
      JJ=J+(I-1)*NMA(1)                                                 DRA1730
      LA=1+(J-1+(I-1)*NMA(1))*NSCWMIN                                   DRA1740
      GAM(J)=CCC(JJ)                                                    DRA1750
      XC4(J)=CRR(JJ)                                                    DRA1760
      Z(J)=XCC4(JJ)                                                     DRA1770
      PHII(J)=YQ(LA)                                                    DRA1780
  200 CONTINUE                                                          DRA1790
      IUZ=NSSWSV(I)                                                     DRA1800
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```
      DO 210 LBLAIR=1,IUZ                                                    DRA1810
      LI=LI+1                                                                DRA1820
      LU=1+TBLE                                                              DRA1830
      LBLR=LBLR+1                                                            DRA1840
      YBB=Q(LU)                                                              DRA1850
      II=II+1                                                                DRA1860
      TBLE=TBLE+TBLSCW(II)                                                   DRA1870
      YOOB=YBB/BOT                                                           DRA1880
      CALL FTLUP (YBB,CDRAGIT,+1,IAMM,PHII,GAM)                              DRA1890
      CALL FTLUP (YBB,CTT,+1,IAMM,PHII,XC4)                                  DRA1900
      CALL FTLUP (YBB,CST,+1,IAMM,PHII,Z)                                    DRA1910
      LL=LBLAIR+(I-1)*NSSWSV(1)                                              DRA1920
      SWALE=ATAN(SSWWA(LL))*57.29578                                         DRA1930
      IF (II.EQ.(NSSWSV(1)+1)) WRITE (6,240)                                 DRA1940
      WRITE (6,260) LI,YOOB,SWALE,CDRAGIT,CTT,CST                            DRA1950
      BLAIR(LBLR)=CST                                                        DRA1960
210   CONTINUE                                                               DRA1970
      IF (NSSWSV(2).EQ.0) GO TO 230                                          DRA1980
220   CONTINUE                                                               DRA1990
230   CDCL2=CDRAG/CLDES**2                                                   DRA2000
      WRITE (6,270) CDCL2,CTHRUST,CSUCT                                      DRA2010
      RETURN                                                                 DRA2020
C                                                                            DRA2030
C                                                                            DRA2040
C                                                                            DRA2050
240   FORMAT (/37X,62HCONTRIBUTION OF THE SECOND PLANFORM TO THE CHORD ODRA2060
     1R DRAG FORCE/)                                                         DRA2070
250   FORMAT (////30X,73HINDUCED DRAG, LEADING EDGE THRUST AND SUCTION CDRA2080
     1OEFFICIENT CHARACTERISTICS/40X,53HCOMPUTED AT THE DESIRED CL FROM DRA2090
     2A NEAR FIELD SOLUTION//58X,20HSECTION COEFFICIENTS/48X,11HL. E. SWDRA2100
     3EEP/25X,7HSTATION,9X,5H 2Y/B,5X,5HANGLE,7X,9HCDII C/2B,5X,7HCT C/2DRA2110
     4B,5X,7HCS C/2B)                                                        DRA2120
260   FORMAT (20X,I10,5X,5F12.5)                                             DRA2130
270   FORMAT (///57X,18HTOTAL COEFFICIENTS//36X,12HCDII/CL**2 =F10.5,5X,DRA2140
     13HCT=,F10.5,5X,3HCS=,F10.5)                                            DRA2150
      END                                                                    DRA2160-
```

# APPENDIX C

```
      SUBROUTINE FTLUP (X,Y,M,N,VARI,VARD)                                  TLU  10
C     ***DOCUMENT DATE 09-12-69    SUBROUTINE REVISED 07-07-69 *********TLU  20
C        MODIFICATION OF LIBRARY INTERPOLATION SUBROUTINE  FTLUP            TLU  30
      DIMENSION VARI(1), VARD(1), V(3), YY(2)                               TLU  40
      DIMENSION II(43)                                                      TLU  50
C                                                                           TLU  60
C      INITIALIZE ALL INTERVAL POINTERS TO -1.0   FOR MONOTONICITY CHECKTLU  70
      DATA (II(J),J=1,43)/43*-1/                                            TLU  80
      MA=IABS(M)                                                            TLU  90
C                                                                           TLU 100
C            ASSIGN INTERVAL POINTER FOR GIVEN VARI TABLE                   TLU 110
C      THE SAME POINTER WILL BE USED ON A GIVEN VARI TABLE EVERY TIME       TLU 120
      LI=MOD(LOCF(VARI(1)),43)+1                                            TLU 130
      I=II(LI)                                                              TLU 140
      IF (I.GE.0) GO TO 60                                                  TLU 150
      IF (N.LT.2) GO TO 60                                                  TLU 160
C                                                                           TLU 170
C     MONOTONICITY CHECK                                                    TLU 180
      IF (VARI(2)-VARI(1)) 20,20,40                                         TLU 190
C     ERROR IN MONOTONICITY                                                 TLU 200
10    K=LOCF(VARI(1))                                                       TLU 210
      PRINT 170, J,K,(VARI(J),J=1,N),(VARD(J),J=1,N)                        TLU 220
      STOP                                                                  TLU 230
C     MONOTONIC DECREASING                                                  TLU 240
20    DO 30 J=2,N                                                           TLU 250
      IF (VARI(J)-VARI(J-1)) 30,10,10                                       TLU 260
30    CONTINUE                                                              TLU 270
      GO TO 60                                                              TLU 280
C     MONOTONIC INCREASING                                                  TLU 290
40    DO 50 J=2,N                                                           TLU 300
      IF (VARI(J)-VARI(J-1)) 10,10,50                                       TLU 310
50    CONTINUE                                                              TLU 320
C                                                                           TLU 330
C     INTERPOLATION                                                         TLU 340
60    IF (I.LE.0) I=1                                                       TLU 350
      IF (I.GE.N) I=N-1                                                     TLU 360
      IF (N.LE.1) GO TO 70                                                  TLU 370
      IF (MA.NE.0) GO TO 80                                                 TLU 380
C     ZERO ORDER                                                            TLU 390
70    Y=VARD(1)                                                             TLU 400
      GO TO 160                                                             TLU 410
C     LOCATE I INTERVAL (X(I).LE.X.LT.X(I+1))                               TLU 420
80    IF ((VARI(I)-X)*(VARI(I+1)-X)) 110,110,90                             TLU 430
C     IN GIVES DIRECTION FOR SEARCH OF INTERVALS                            TLU 440
90    IN=SIGN(1.0,(VARI(I+1)-VARI(I))*(X-VARI(I)))                          TLU 450
C     IF X OUTSIDE ENDPOINTS, EXTRAPOLATE FROM END INTERVAL                 TLU 460
100   IF ((I+IN).LE.0) GO TO 110                                            TLU 470
      IF ((I+IN).GE.N) GO TO 110                                            TLU 480
      I=I+IN                                                                TLU 490
      IF ((VARI(I)-X)*(VARI(I+1)-X)) 110,110,100                            TLU 500
110   IF (MA.EQ.2) GO TO 120                                                TLU 510
C                                                                           TLU 520
C     FIRST ORDER                                                           TLU 530
      Y=(VARD(I)*(VARI(I+1)-X)-VARD(I+1)*(VARI(I)-X))/(VARI(I+1)-VARI(I))TLU 540
     1)                                                                     TLU 550
      GO TO 160                                                             TLU 560
C                                                                           TLU 570
C     SECOND ORDER                                                          TLU 580
120   IF (N.EQ.2) GO TO 10                                                  TLU 590
      IF (I.EQ.(N-1)) GO TO 140                                             TLU 600
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      IF (I.EQ.1) GO TO 130                                                    TLU 610
C     PICK THIRD POINT                                                         TLU 620
      SK=VARI(I+1)-VARI(I)                                                     TLU 630
      IF ((SK*(X-VARI(I-1))).LT.(SK*(VARI(I+2)-X))) GO TO 140                  TLU 640
130   L=I                                                                      TLU 650
      GO TO 150                                                                TLU 660
140   L=I-1                                                                    TLU 670
150   V(1)=VARI(L)-X                                                           TLU 680
      V(2)=VARI(L+1)-X                                                         TLU 690
      V(3)=VARI(L+2)-X                                                         TLU 700
      YY(1)=(VARD(L)*V(2)-VARD(L+1)*V(1))/(VARI(L+1)-VARI(L))                  TLU 710
      YY(2)=(VARD(L+1)*V(3)-VARD(L+2)*V(2))/(VARI(L+2)-VARI(L+1))              TLU 720
      Y=(YY(1)*V(3)-YY(2)*V(1))/(VARI(L+2)-VARI(L))                            TLU 730
160   II(LI)=I                                                                 TLU 740
      RETURN                                                                   TLU 750
C                                                                              TLU 760
C                                                                              TLU 770
170   FORMAT (1H1,50H TABLE BELOW OUT OF ORDER FOR FTLUP  AT POSITION          *TLU 780
     1I5,/31H X TABLE IS STORED IN LOCATION ,06,//(8G15.8))                    TLU 790
      END                                                                      TLU 800-
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# APPENDIX C

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      OVERLAY(WINGTL,5,0)                                                    TIP  10
      PROGRAM TIPSUCT                                                        TIP  20
      DIMENSION YY(2), WVOU(60), FV(2), FW(2), XTLEG(60), CIRSUM(50), YLTIP  30
     1EGSV(50), ZLEGSV(50)                                                   TIP  40
      COMMON /ALL/ BOT,M,BETA,PTEST,QTSST,TBLSCW(50),Q(200),PN(200),PV(2TIP  50
     100),ALP(200),S(200),PSI(200),PHI(50),ZH(50)                            TIP  60
      COMMON /TOTHRE/ CIR(200,2)                                             TIP  70
      COMMON /ONETHRE/ TWIST(2),CREF,SREF,CAVE,CLDES,STRUE,AR,ARTRUE,RTCTIP  80
     1DHT(2),CONFIG,NSSWSV(2),MSV(2),KBOT,PLAN,IPLAN,MACH,SSWWA(50),XL(2TIP  90
     2),XT(2),CLWB,CMCL,CLA(2),BLAIR(50),CLAMAR(2)                          TIP 100
      COMMON /THREFOR/ CCAV(2,50),CLT,CLNT,NSSW,ALPD                         TIP 110
      COMMON /INSUB23/ APSI,APHI,XX,YYY,ZZ,SNN,TOLCSQ                        TIP 120
      DIMENSION XKVSEW(2), CENTR(2)                                          TIP 130
      XKVSEW(1)=XKVSEW(2)=CENTR(1)=CENTR(2)=0.0                              TIP 140
      IF (IPLAN.EQ.1.AND.XL(1).EQ.XT(1)) GO TO 540                           TIP 150
      IF (XL(1).EQ.XT(1).AND.XL(2).EQ.XT(2)) GO TO 540                       TIP 160
      BLAMAR=1./BETA                                                         TIP 170
      XT(1)=XT(1)*BLAMAR                                                     TIP 180
      XT(2)=XT(2)*BLAMAR                                                     TIP 190
      XL(1)=XL(1)*BLAMAR                                                     TIP 200
      XL(2)=XL(2)*BLAMAR                                                     TIP 210
C                                                                            TIP 220
C     THE TOLERANCE SET AT THIS POINT IN THE PROGRAM MAY NEED TO BE          TIP 230
C     CHANGED FOR COMPUTERS OTHER THAN THE CDC 6000 SERIES                   TIP 240
C                                                                            TIP 250
      TOLC=.0100*BOT                                                         TIP 260
      TOLCSQ=TOLC*TOLC                                                       TIP 270
C                                                                            TIP 280
C                                                                            TIP 290
      TIPSU=PITCH=0.                                                         TIP 300
      NSSW=NSSWSV(1)+NSSWSV(2)                                               TIP 310
C                                                                            TIP 320
C                                                                            TIP 330
C     GEOMETRY FOR TIP TRAILING LEGS                                         TIP 340
C                                                                            TIP 350
      ITT=1                                                                  TIP 360
      IM=IMM=NSSW1=0                                                         TIP 370
      CCIRS=0.                                                               TIP 380
      NSSW2=NSSW3=NSSWSV(1)                                                  TIP 390
      L=1                                                                    TIP 400
      NSCW=MSV(1)/NSSWSV(1)                                                  TIP 410
      GO TO 20                                                               TIP 420
10    NSSW1=NSSWSV(1)                                                        TIP 430
      NSSW2=NSSW$NSSW3=NSSWSV(2)                                             TIP 440
      L=NSSWSV(1)+1                                                          TIP 450
      NSCW=MSV(2)/NSSWSV(2)                                                  TIP 460
      IF (XL(2).EQ.XT(2)) GO TO 500                                          TIP 470
20    I=IMM+1                                                                TIP 480
      J=IMM+2                                                                TIP 490
      IUU=2                                                                  TIP 500
      APHI=ATAN(PHI(IM+1))                                                   TIP 510
      SA=SIN(APHI)                                                           TIP 520
      CA=COS(APHI)                                                           TIP 530
      TLX1=PN(I)-S(I)*TAN(PSI(I))*CA                                         TIP 540
      TLX2=PN(J)-S(J)*TAN(PSI(J))*CA                                         TIP 550
      CLFTLG=TLX1-TLX2                                                       TIP 560
      XTLEG(1)=TLX1/2.+TLX2/2.                                               TIP 570
      YLEG=Q(I)-S(I)*CA                                                      TIP 580
      IF (NSSW1.EQ.0) YLEGSV(1)=YLEG                                         TIP 590
      ZLEG=ZH(IM+1)-S(I)*SA                                                  TIP 600
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      IF (NSSW1.EQ.0) ZLEGSV(1)=ZLEG                                    TIP 610
      IF (XL(ITT).EQ.XT(ITT)) GO TO 100                                 TIP 620
      DO 30 NV=2,NSCW                                                   TIP 630
      NVT=NV-1                                                          TIP 640
30    XTLEG(NV)=XTLEG(NVT)-CLFTLG                                       TIP 650
      NCTL=0                                                            TIP 660
      NA=1                                                              TIP 670
      NB=NSCW                                                           TIP 680
40    DO 70 NV=NA,NB                                                    TIP 690
C                                                                       TIP 700
C                                                                       TIP 710
C     THE RATIO OF W/U IS INITIALIZED TO -1 BECAUSE IN THE TERM         TIP 720
C     -U*ALPHA/U,USED IN THIS SUMMATION, ALPHA IS SET TO 1 RADIAN       TIP 730
C     SO THAT THE RESULTING TIP SUCTION CAN BE USED DIRECTLY TO FIND    TIP 740
C     KV SIDE EDGE                                                      TIP 750
C                                                                       TIP 760
C                                                                       TIP 770
      WVOU(NV)=-1.                                                      TIP 780
      IZ=1                                                              TIP 790
      NNN=TBLSCW(IZ)                                                    TIP 800
      DO 60 NN=1,M                                                      TIP 810
      APHI=ATAN(PHI(IZ))                                                TIP 820
      APSI=PSI(NN)                                                      TIP 830
      XX=XTLEG(NV)-PN(NN)                                               TIP 840
      YY(1)=YLEG-Q(NN)                                                  TIP 850
      YY(2)=YLEG+Q(NN)                                                  TIP 860
      ZZ=ZLEG-ZH(IZ)                                                    TIP 870
      SNN=S(NN)                                                         TIP 880
      DO 50 I=1,2                                                       TIP 890
      YYY=YY(I)                                                         TIP 900
      CALL INFSUB (BOT,FV(I),FW(I))                                     TIP 910
      APHI=-APHI$APSI=-APSI                                             TIP 920
50    CONTINUE                                                          TIP 930
      WVOU(NV)=WVOU(NV)+(FW(1)+FW(2))*CIR(NN,2)/12.5663704              TIP 940
      IF (NN.LT.NNN.OR.NV.EQ.M) GO TO 60                                TIP 950
      IZ=IZ+1                                                           TIP 960
      NNN=NNN+TBLSCW(IZ)                                                TIP 970
60    CONTINUE                                                          TIP 980
70    CONTINUE                                                          TIP 990
      NCTL=NCTL+1                                                       TIP1000
      IF (NCTL-2) 80,100,150                                            TIP1010
C                                                                       TIP1020
C     GEOMETRY FOR SPANWISE BOUND VORTICES                              TIP1030
C                                                                       TIP1040
80    NA=NSCW+1                                                         TIP1050
      NB=2*NSCW                                                         TIP1060
      JA=IMM+1                                                          TIP1070
      YLEG=Q(JA)                                                        TIP1080
      ZLEG=ZH(IM+1)                                                     TIP1090
      DO 90 J=1,NSCW                                                    TIP1100
      JK=IMM+J                                                          TIP1110
      NV=J+NSCW                                                         TIP1120
90    XTLEG(NV)=PN(JK)                                                  TIP1130
      GO TO 40                                                          TIP1140
C                                                                       TIP1150
C     GEOMETRY ALONG RIGHT TRAILING LEGS                                TIP1160
C                                                                       TIP1170
100   NA=2*NSCW+1                                                       TIP1180
      NB=3*NSCW                                                         TIP1190
      CCIRS=0.                                                          TIP1200
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      JK=IMM+1                                                                  TIP1210
      APHI=ATAN(PHI(IM+1))                                                      TIP1220
      SA=SIN(APHI)                                                              TIP1230
      CA=COS(APHI)                                                              TIP1240
      YLEG=Q(JK)+S(JK)*CA                                                       TIP1250
      IF (NSSW1.EQ.0) YLEGSV(IUU)=YLEG                                          TIP1260
      ZLEG=ZH(IM+1)+S(JK)*SA                                                    TIP1270
      IF (NSSW1.EQ.0) ZLEGSV(IUU)=ZLEG                                          TIP1280
      IF (XL(ITT).EQ.XT(ITT)) GO TO 150                                         TIP1290
      TLX1=PN(JK)+S(JK)*TAN(PSI(JK))*CA                                         TIP1300
      JK=JK+1                                                                   TIP1310
      TLX2=PN(JK)+S(JK)*TAN(PSI(JK))*CA                                         TIP1320
      CRTTLG=TLX1-TLX2                                                          TIP1330
      XTLEG(NA)=TLX1/2.+TLX2/2.                                                 TIP1340
      NAA=NA+1                                                                  TIP1350
      IF (NSSW1.EQ.NSSWSV(1)) GO TO 110                                         TIP1360
      GO TO 130                                                                 TIP1370
110   DO 120 II=2,L                                                             TIP1380
      IQ=IT-1                                                                   TIP1390
      IF ((ABS(YLEGSV(IT)-YLEG).LT.TOLC).AND.(ABS(ZLEGSV(IT)-ZLEG).LT.TOTIP1400
     1LC)) CCIRS=CIRSUM(IQ)                                                     TIP1410
      IF (CCIRS.NE.0.) GO TO 130                                                TIP1420
120   CONTINUE                                                                  TIP1430
130   DO 140 NV=NAA,NB                                                          TIP1440
      NVT=NV-1                                                                  TIP1450
140   XTLEG(NV)=XTLEG(NVT)-CRTTLG                                               TIP1460
      GO TO 40                                                                  TIP1470
C                                                                               TIP1480
C                                                                               TIP1490
150   CONTINUE                                                                  TIP1500
      IF (CCIRS.NE.0.) GO TO 160                                                TIP1510
      GO TO 270                                                                 TIP1520
160   IJ=2*NSCW+1                                                               TIP1530
      XLT=XTLEG(1)+CLFTLG/2.                                                    TIP1540
      XRT=XTLEG(IJ)+CRTTLG/2.                                                   TIP1550
      XLL=XLT+CLFTLG/4.                                                         TIP1560
      XRL=XRT+CRTTLG/4.                                                         TIP1570
      IF (XLL.GE.XL(ITT).AND.XLT.LE.XT(ITT)) GO TO 170                          TIP1580
      IF (XLL.LE.XL(ITT).AND.XLT.GE.XT(ITT)) GO TO 190                          TIP1590
      IF (XLL.GT.XL(ITT).AND.XLT.GE.XL(ITT)) GO TO 200                          TIP1600
      IF (XLL.LE.XT(ITT)) GO TO 200                                             TIP1610
      IF (XLL.GT.XL(ITT).AND.XLT.LT.XL(ITT)) GO TO 180                          TIP1620
      CON4=(XT(ITT)-XLL)/(XLT-XLL)                                              TIP1630
      GO TO 210                                                                 TIP1640
170   CON4=(XL(ITT)-XT(ITT))/(XLL-XLT)                                          TIP1650
      GO TO 210                                                                 TIP1660
180   CON4=(XL(ITT)-XLT)/(XLL-XLT)                                              TIP1670
      GO TO 210                                                                 TIP1680
190   CON4=1.                                                                   TIP1690
      GO TO 210                                                                 TIP1700
200   CON4=0.0                                                                  TIP1710
210   CONTINUE                                                                  TIP1720
      IF (XRL.GE.XL(ITT).AND.XRT.LE.XT(ITT)) GO TO 220                          TIP1730
      IF (XRL.LE.XL(ITT).AND.XRT.GE.XT(ITT)) GO TO 240                          TIP1740
      IF (XRL.GT.XL(ITT).AND.XRT.GE.XL(ITT)) GO TO 250                          TIP1750
      IF (XRL.LE.XT(ITT)) GO TO 250                                             TIP1760
      IF (XRL.GT.XL(ITT).AND.XRT.LT.XL(ITT)) GO TO 230                          TIP1770
      CON5=(XT(ITT)-XRL)/(XRT-XRL)                                              TIP1780
      GO TO 260                                                                 TIP1790
220   CON5=(XL(ITT)-XT(ITT))/(XRL-XRT)                                          TIP1800
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      GO TO 260                                                          TIP1810
230   CON5=(XL(ITT)-XRT)/(XRL-XRT)                                       TIP1820
      GO TO 260                                                          TIP1830
240   CON5=1.                                                            TIP1840
      GO TO 260                                                          TIP1850
250   CON5=0.0                                                           TIP1860
260   CONTINUE                                                           TIP1870
      TIPSU=TIPSU+CCIRS*0.25*(CON4*WVOU(1)*CLFTLG-CON5*WVOU(IJ)*CRTTLG)*TIP1880
     12./SREF*BETA                                                       TIP1890
      PITCH=PITCH+CCIRS*0.25*(-CON4*WVOU(1)*CLFTLG*XTLEG(1)+CON5*WVOU(IJTIP1900
     1)*CRTTLG*XTLEG(IJ))*2./(SREF*CREF)*BETA**2                         TIP1910
270   CIRCUS=CCIRS                                                       TIP1920
      DO 460 NPOS=1,NSCW                                                 TIP1930
      JK=IMM+NPOS                                                        TIP1940
      JN=2*NSCW+NPOS                                                     TIP1950
      NPIS=NSCW+NPOS                                                     TIP1960
      CIRCUS=CIRCUS+CIR(JK,2)                                            TIP1970
      IF (XL(ITT).EQ.XT(ITT)) GO TO 460                                  TIP1980
      XLLEG=XTLEG(NPOS)                                                  TIP1990
      XRLEG=XTLEG(JN)                                                    TIP2000
      XLL=XTLEG(NPOS)+CLFTLG/2.                                          TIP2010
      XLT=XTLEG(NPOS)-CLFTLG/2.                                          TIP2020
      XRL=XTLEG(JN)+CRTTLG/2.                                            TIP2030
      XRT=XTLEG(JN)-CRTTLG/2.                                            TIP2040
      IF (XLL.GE.XL(ITT).AND.XLT.LE.XT(ITT)) GO TO 280                   TIP2050
      IF (XLL.LE.XL(ITT).AND.XLT.GE.XT(ITT)) GO TO 300                   TIP2060
      IF (XLL.GT.XL(ITT).AND.XLT.GE.XL(ITT)) GO TO 310                   TIP2070
      IF (XLL.LE.XT(ITT)) GO TO 310                                      TIP2080
      IF (XLL.GT.XL(ITT).AND.XLT.LT.XL(ITT)) GO TO 290                   TIP2090
      CON1=(XT(ITT)-XLL)/(XLT-XLL)                                       TIP2100
      XLLEG=XT(ITT)+CON1*CLFTLG/2.                                       TIP2110
      GO TO 320                                                          TIP2120
280   CON1=(XL(ITT)-XT(ITT))/(XLL-XLT)                                   TIP2130
      XLLEG=(XL(ITT)+XT(ITT))/2.                                         TIP2140
      GO TO 320                                                          TIP2150
290   CON1=(XL(ITT)-XLT)/(XLL-XLT)                                       TIP2160
      XLLEG=XLT+CON1*CLFTLG/2.                                           TIP2170
      GO TO 320                                                          TIP2180
300   CON1=1.                                                            TIP2190
      GO TO 320                                                          TIP2200
310   CON1=0.0                                                           TIP2210
320   CONTINUE                                                           TIP2220
      IF (NPOS.EQ.NSCW.AND.CON1.EQ.1.) GO TO 360                         TIP2230
      IF (XRL.GE.XL(ITT).AND.XRT.LE.XT(ITT)) GO TO 330                   TIP2240
      IF (XRL.LE.XL(ITT).AND.XRT.GE.XT(ITT)) GO TO 350                   TIP2250
      IF (XRL.GT.XL(ITT).AND.XRT.GE.XL(ITT)) GO TO 370                   TIP2260
      IF (XRL.LE.XT(ITT)) GO TO 370                                      TIP2270
      IF (XRL.GT.XL(ITT).AND.XRT.LT.XL(ITT)) GO TO 340                   TIP2280
      CON2=(XT(ITT)-XRL)/(XRT-XRL)                                       TIP2290
      XRLEG=XT(ITT)+CON2*CRTTLG/2.                                       TIP2300
      GO TO 380                                                          TIP2310
330   CON2=(XL(ITT)-XT(ITT))/(XRL-XRT)                                   TIP2320
      XRLEG=(XL(ITT)+XT(ITT))/2.                                         TIP2330
      GO TO 380                                                          TIP2340
340   CON2=(XL(ITT)-XRT)/(XRL-XRT)                                       TIP2350
      XRLEG=XRT+CON2*CRTTLG/2.                                           TIP2360
      GO TO 380                                                          TIP2370
350   CON2=1.                                                            TIP2380
      GO TO 380                                                          TIP2390
360   CON1=.75                                                           TIP2400
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      CON2=.75                                                          TIP2410
      GO TO 380                                                         TIP2420
370   CON2=0.0                                                          TIP2430
380   IF (XRL.GT.XLL) GO TO 390                                         TIP2440
      XSIGN=-1.0                                                        TIP2450
      XBLL=XLL                                                          TIP2460
      XBLT=XRL                                                          TIP2470
      GO TO 400                                                         TIP2480
390   XBLL=XRL                                                          TIP2490
      XBLT=XLL                                                          TIP2500
      XSIGN=1.                                                          TIP2510
400   BVDLG=ABS(XBLL-XBLT)                                              TIP2520
      IF (XBLT.GE.XL(ITT)) GO TO 440                                    TIP2530
      IF (XBLL.LE.XT(ITT)) GO TO 440                                    TIP2540
      IF (XBLL.GE.XL(ITT).AND.XBLT.LE.XT(ITT)) GO TO 430                TIP2550
      IF (XBLL.LE.XL(ITT).AND.XBLT.GE.XT(ITT)) GO TO 420                TIP2560
      IF (XBLL.GT.XL(ITT).AND.XBLT.GE.XT(ITT)) GO TO 410                TIP2570
      CON3=(XT(ITT)-XBLL)/(XBLT-XBLL)                                   TIP2580
      XTLEG(NPIS)=XT(ITT)+CON3*BVDLG/2.                                 TIP2590
      CON3=CON3*XSIGN                                                   TIP2600
      GO TO 450                                                         TIP2610
410   CON3=(XL(ITT)-XBLT)/(XBLL-XBLT)                                   TIP2620
      XTLEG(NPIS)=XBLT+CON3*BVDLG/2.                                    TIP2630
      CON3=CON3*XSIGN                                                   TIP2640
      GO TO 450                                                         TIP2650
420   CON3=1.*XSIGN                                                     TIP2660
      GO TO 450                                                         TIP2670
430   CON3=(XL(ITT)-XT(ITT))/(XBLL-XBLT)                                TIP2680
      XTLEG(NPIS)=(XL(ITT)+XT(ITT))/2.                                  TIP2690
      CON3=CON3*XSIGN                                                   TIP2700
      GO TO 450                                                         TIP2710
440   CON3=0.0                                                          TIP2720
450   TIPSU=TIPSU+(CIRCUS*(WVOU(NPOS)*CLFTLG*CON1-CON2*WVOU(JN)*CRTTLG)+TIP2730
     1CIR(JK,2)*(WVOU(NPIS)*CON3*BVDLG))*2./SREF*BETA                   TIP2740
      PITCH=PITCH+(CIRCUS*(-WVOU(NPOS)*CLFTLG*CON1*XLLEG+WVOU(JN)*CON2*CTIP2750
     1RTTLG*XRLEG)-CIR(JK,2)*(WVOU(NPIS)*CON3*BVDLG*XTLEG(NPIS)))*2./(STIP2760
     2EF*CREF)*BETA**2                                                  TIP2770
460   CONTINUE                                                          TIP2780
      IM=IM+1                                                           TIP2790
      IMM=IMM+IBLSCW(IM)                                                TIP2800
      IF (NSSWI.EQ.0) CIRSUM(IM)=CIRCUS                                 TIP2810
      IF (NSSWI.EQ.0) IUU=IM+2                                          TIP2820
      IF (IM.EQ.NSSWSV(1)) GO TO 470                                    TIP2830
      IF (XL(ITT).EQ.XT(ITT)) GO TO 100                                 TIP2840
      GO TO 480                                                         TIP2850
470   CTSW=TIPSU                                                        TIP2860
      CMW=PITCH                                                         TIP2870
      IF (NSSW2.EQ.NSSW) GO TO 520                                      TIP2880
      ITT=2                                                             TIP2890
      GO TO 10                                                          TIP2900
480   IF (IM.EQ.NSSW) GO TO 500                                         TIP2910
      NCTL=1                                                            TIP2920
      DO 490 NV=1,NSCW                                                  TIP2930
      CLFTLG=CRTTLG                                                     TIP2940
      NY=NV+2*NSCW                                                      TIP2950
      XTLEG(NV)=XTLEG(NY)                                               TIP2960
490   WVOU(NV)=WVOU(NY)                                                 TIP2970
      GO TO 80                                                          TIP2980
500   XKVSEW(2)=2.*ABS(TIPSU-CTSW)                                      TIP2990
      IF (XKVSEW(2).LT.0.000001) GO TO 510                              TIP3000
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      CENTR(2)=(PITCH-CMW)*CREF/ABS(TIPSU-CTSW)                    TIP3010
      GO TO 520                                                    TIP3020
  510 CENTR(2)=0.0                                                 TIP3030
  520 XKVSEW(1)=2.*ABS(CTSW)                                       TIP3040
      IF (XKVSEW(1).LT.0.000001) GO TO 530                         TIP3050
      CENTR(1)=CMW*CREF/ABS(CTSW)                                  TIP3060
      GO TO 540                                                    TIP3070
  530 CENTR(1)=0.0                                                 TIP3080
  540 CALL WRTANS (XKVSEW,CENTR)                                   TIP3090
      RETURN                                                       TIP3100
      END                                                          TIP3110-
```

# APPENDIX C

```
      SUBROUTINE WRTANS (XKVSEW,CENTR)                                  WRT  10
      COMMON /ALL/ BOT,M,BETA,PTEST,QTEST,TBLSCW(50),Q(200),PN(200),PV(2WRT  20
     100),ALP(200),S(200),PSI(200),PHI(50),ZH(50)                       WRT  30
      COMMON /ONETHRE/ TWIST(2),CREF,SREF,CAVE,CLDES,STRUE,AR,ARTRUE,RTCWRT  40
     1DHT(2),CONFIG,NSSWSV(2),MSV(2),KBOT,PLAN,IPLAN,MACH,SSWWA(50),XL(2WRT  50
     2),XT(2),CLWB,CMCL,CLA(2),BLAIR(50),CLAMAR(2)                      WRT  60
      COMMON /THREFOR/ CCAV(2,50),CLT,CLNT,NSSW,ALPD                    WRT  70
      DIMENSION XKV(2), XKP(2), YCHLO(2), YCHHI(2), CENTR(2), CENT(2), XWRT  80
     1KVSEW(2)                                                          WRT  90
      LCH=0                                                             WRT 100
      LAMAR=NSSWSV(1)                                                   WRT 110
      SUMY=SUM=0.0                                                      WRT 120
      CONV=3.1415926536/180.                                            WRT 130
      CINV=1./(3.1415926536*AR)                                         WRT 140
      DELTA=2.*CONV                                                     WRT 150
      CONST=16.*BOT/SREF                                                WRT 160
      ALPHA=ALPD*CONV                                                   WRT 170
      S22=ALPHA**2                                                      WRT 180
      KBT=1                                                             WRT 190
      IF (KBOT.EQ.1) KBT=2                                              WRT 200
      IF (IPLAN.EQ.1) GO TO 10                                          WRT 210
      XKP(KBOT)=CLWB/ALPHA                                              WRT 220
      XKP(KBT)=(CLDES-CLWB)/ALPHA                                       WRT 230
      GO TO 20                                                          WRT 240
10    XKP(1)=CLA(2)                                                     WRT 250
20    READ (5,180) YCHLO(1),YCHHI(1),YCHLO(2),YCHHI(2)                  WRT 260
      NCH=1                                                             WRT 270
      NC1=NSSWSV(1)                                                     WRT 280
      DO 40 J=1,NC1                                                     WRT 290
      IF (Q(NCH).GT.YCHLO(1)) GO TO 30                                  WRT 300
      IF (Q(NCH).LT.YCHHI(1)) GO TO 30                                  WRT 310
      SUM=SUM+(PN(NCH)+(PN(NCH)-PN(NCH+1))/4.)*BETA*BLAIR(J)*S(NCH)*CONSWRT 320
     1T                                                                 WRT 330
      SUMY=SUMY+BLAIR(J)*S(NCH)*CONST                                   WRT 340
      IF (J.EQ.NC1) GO TO 40                                            WRT 350
30    NCH=NCH+TBLSCW(J)                                                 WRT 360
40    CONTINUE                                                          WRT 370
      XKV(1)=SUMY/S22                                                   WRT 380
      IF (XKV(1).LT.0.000001) GO TO 50                                  WRT 390
      CENT(1)=SUM/SUMY                                                  WRT 400
      GO TO 60                                                          WRT 410
50    CENT(1)=0.0                                                       WRT 420
60    CONTINUE                                                          WRT 430
      IF (IPLAN.EQ.1) GO TO 100                                         WRT 440
      SUMY=SUM=0.0                                                      WRT 450
      NCH=MSV(1)+1                                                      WRT 460
      NC2=NSSWSV(2)                                                     WRT 470
      DO 80 J=1,NC2                                                     WRT 480
      IF (Q(NCH).GT.YCHLO(2)) GO TO 70                                  WRT 490
      IF (Q(NCH).LT.YCHHI(2)) GO TO 70                                  WRT 500
      SUM=SUM+(PN(NCH)+(PN(NCH)-PN(NCH+1))/4.)*BETA*BLAIR(NC1+J)*S(NCH)*WRT 510
     1CONST                                                             WRT 520
      SUMY=SUMY+BLAIR(NC1+J)*S(NCH)*CONST                               WRT 530
      IF (J.EQ.NC2) GO TO 80                                            WRT 540
70    NCH=NCH+TBLSCW(J+LAMAR)                                           WRT 550
80    CONTINUE                                                          WRT 560
      XKV(2)=SUMY/S22                                                   WRT 570
      IF (XKV(2).LT.0.000001) GO TO 90                                  WRT 580
      CENT(2)=SUM/SUMY                                                  WRT 590
      GO TO 100                                                         WRT 600
```

```
90    CENT(2)=0.0                                                              WRT 610
100   CONTINUE                                                                 WRT 620
      WRITE (6,190)                                                            WRT 630
      DO 110 IK=1,IPLAN                                                        WRT 640
      CENTPM=CLAMAR(IK)*CREF                                                   WRT 650
      WRITE (6,200) IK                                                         WRT 660
      WRITE (6,210) XKP(IK),CENTPM                                             WRT 670
      WRITE (6,220) XKV(IK),CENT(IK)                                           WRT 680
110   WRITE (6,230) XKVSEW(IK),CENTR(IK)                                       WRT 690
120   CONTINUE                                                                 WRT 700
      DO 160 IK=1,IPLAN                                                        WRT 710
      IF (LCH.EQ.1) GO TO 130                                                  WRT 720
      WRITE (6,240) IK                                                         WRT 730
130   WRITE (6,250)                                                            WRT 740
      ALPHA=0.0                                                                WRT 750
      DO 160 J=1,26                                                            WRT 760
      V=SIN(ALPHA)                                                             WRT 770
      C=COS(ALPHA)                                                             WRT 780
      C2=C**2                                                                  WRT 790
      S2=V**2                                                                  WRT 800
      CLP=XKP(IK)*V*C2                                                         WRT 810
      CLVL=CLP+XKV(IK)*S2*C                                                    WRT 820
      CLSL=CLP+XKVSEW(IK)*C*S2                                                 WRT 830
      CLTOT=CLVL+XKVSEW(IK)*C*S2                                               WRT 840
      IF (LCH.EQ.0) GO TO 140                                                  WRT 850
      CMP=V*C*(XKP(2)*CLAMAR(2)+(XKP(1)-XKP(2))*CLAMAR(1))                     WRT 860
      CMPL=CMP+S2/CREF*(CENT(2)*XKV(2)+(XKV(1)-XKV(2))*CENT(1))                WRT 870
      CMPS=CMP+S2/CREF*(CENTR(2)*XKVSEW(2)+(XKVSEW(1)-XKVSEW(2))*CENTR(1WRT 880
     1))                                                                       WRT 890
      CMTOT=CMPL+CMPS-CMP                                                      WRT 900
      GO TO 150                                                                WRT 910
140   CMP=CLAMAR(IK)*XKP(IK)*V*C                                               WRT 920
      CMPL=CMP+CENT(IK)*XKV(IK)*S2/CREF                                        WRT 930
      CMPS=CMP+XKVSEW(IK)*CENTR(IK)*S2/CREF                                    WRT 940
      CMTOT=CMPL+XKVSEW(IK)*CENTR(IK)*S2/CREF                                  WRT 950
150   CDI=CLTOT*TAN(ALPHA)                                                     WRT 960
      CDII=(CLTOT**2)*CINV                                                     WRT 970
      ALPH1=ALPHA/CONV                                                         WRT 980
      CNTT=CLTOT/C                                                             WRT 990
      WRITE (6,260) ALPH1,CNTT,CLP,CLVL,CLSL,CLTOT,CMP,CMPL,CMPS,CMTOT,CWRT1000
     1DI,CDII                                                                  WRT1010
160   ALPHA=ALPHA+DELTA                                                        WRT1020
      IF (IPLAN.EQ.1) GO TO 170                                                WRT1030
      IPLAN=1                                                                  WRT1040
      LCH=1                                                                    WRT1050
      WRITE (6,280)                                                            WRT1060
      XKP(1)=XKP(1)+XKP(2)                                                     WRT1070
      XKV(1)=XKV(1)+XKV(2)                                                     WRT1080
      XKVSEW(1)=XKVSEW(1)+XKVSEW(2)                                            WRT1090
      GO TO 120                                                                WRT1100
170   WRITE (6,270)                                                            WRT1110
      IPLAN=PLAN                                                               WRT1120
      RETURN                                                                   WRT1130
C                                                                              WRT1140
C                                                                              WRT1150
C                                                                              WRT1160
180   FORMAT (4F10.5)                                                          WRT1170
190   FORMAT (1H1,////,31X,60HKP , KV AND RESPECTIVE CHORDWISE CENTROIDSWRT1180
     1 FOR EACH PLANFORM)                                                      WRT1190
200   FORMAT (///,52X,12HPLANFORM NO.,I2)                                      WRT1200
```

```
210   FORMAT (40X,3HKP=,F10.5,10X,11HCENTROID AT,F10.5)                    WRT1210
220   FORMAT (37X,6HKV LE=,F10.5,10X,11HCENTROID AT,F10.5)                 WRT1220
230   FORMAT (37X,6HKV SE=,F10.5,10X,11HCENTROID AT,F10.5)                 WRT1230
240   FORMAT (1H1,////,43X,40HPERFORMANCE CHARACTERISTICS FOR PLANFORM,I   WRT1240
     12)                                                                   WRT1250
250   FORMAT (//7X,5HALPHA,6X,2HCN,8X,3HCLP,4X,9HCLP+CLVLE,1X,9HCLP+CLVS   WRT1260
     1E,4X,2HCL,8X,3HCMP,4X,9HCMP+CMVLE,1X,9HCMP+CMVSE,4X,2HCM,8X,2HCD,3  WRT1270
     2X,13HCL**2/(PI*AR)/)                                                 WRT1280
260   FORMAT (3X,12F10.4)                                                  WRT1290
270   FORMAT (///,50X,21HTHIS CASE IS FINISHED)                            WRT1300
280   FORMAT (1H1,////,48X,33HTOTAL PERFORMANCE CHARACTERISTICS)           WRT1310
      END                                                                  WRT1320-
```

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TABLE I.- $K_{v,se}$ AND ITS CHORDWISE CENTROID OBTAINED BY FOUR METHODS FOR THREE PLANFORMS

[M = 0; for method 2, $\overline{N}_c = 6$ and $\overline{N}_s = 25$; for method 3, $\overline{N}_c = 3$ and $\overline{N}_s = 25$; for method 4, $\overline{N}_c = 11$ and $\overline{N}_s = 11$]

| Method | Cropped diamond planform | | Cropped arrow planform | | Cropped delta planform | |
|---|---|---|---|---|---|---|
| | $K_{v,se}$ | $\Delta x/c_t$ | $K_{v,se}$ | $\Delta x/c_t$ | $K_{v,se}$ | $\Delta x/c_t$ |
| 1 | 1.200 | 0.5367 | 1.693 | 0.5320 | 1.397 | 0.5373 |
| 2 | 1.232 | .5207 | 1.726 | .5098 | 1.456 | .5182 |
| 3 | 1.200 | .5451 | 1.688 | .5350 | 1.412 | .5441 |
| 4 | 1.300 | ----- | 1.742 | ----- | 1.60 | ----- |

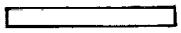
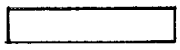
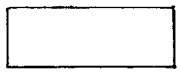
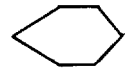
TABLE II.- EFFECT OF BOUND VORTEX SWEEP ANGLE ON $K_{v,se}$ AND $\Delta x/c_t$

[A = 3.5; $\lambda$ = 1.0; M = 0.30; for method 2, $\overline{N}_c = 6$ and $\overline{N}_s = 30$]

| $\Lambda$, deg | Method 1 | | Method 2 | |
|---|---|---|---|---|
| | $K_{v,se}$ | $\Delta x/c_t$ | $K_{v,se}$ | $\Delta x/c_t$ |
| 0 | 1.0968 | 0.6004 | 1.1037 | 0.5956 |
| 20 | 1.3050 | .5777 | 1.3869 | .5325 |
| 40 | 1.4149 | .5486 | 1.3630 | .5270 |
| 50 | 1.3631 | .5418 | 1.3076 | .5164 |
| 60 | 1.2431 | .5464 | 1.1698 | .5066 |
| 70 | .9446 | .5956 | .9243 | .4980 |
| 75 | .8335 | .5729 | .7556 | .4916 |

TABLE III.- POTENTIAL AND VORTEX LIFT FACTORS OBTAINED FROM THE PRESENT METHOD AND METHOD 1

[M = 0; for method 2, $\overline{N}_C = 6$ and $\overline{N}_S = 25$]

| A | Type | Present method (method 2) | | | Method 1 | | |
|---|---|---|---|---|---|---|---|
| | | $K_p$ | $K_{v,le}$ | $K_{v,se}$ | $K_p$ | $K_{v,le}$ | $K_{v,se}$ |
| 0.05 |  | 0.0798 | 0.0399 | 2.9816 | 0.07844 | 0.0393 | 3.1799 |
| .10 |  | .1596 | .0798 | 2.9477 | .1571 | .0785 | 3.0188 |
| .20 |  | .3188 | .1597 | 2.8533 | .3138 | .1571 | 2.7913 |
| .30 |  | .4769 | .2395 | 2.7497 | .4693 | .2356 | 2.7208 |
| .40 |  | .6329 | .3194 | 2.6467 | .6227 | .3141 | 2.6341 |
| 1.00 |  | 1.4862 | .7969 | 2.1157 | 1.4614 | .7816 | 2.1255 |
| 1.00 |  | 1.4475 | .7923 | 2.3581 | 1.4335 | .7787 | 2.3863 |
| [a].873 |  | 1.3064 | 1.5345 | 1.4563 | 1.2789 | 1.5041 | 1.3967 |
| [a]1.069 |  | 1.5049 | 1.8575 | 1.7256 | 1.4868 | 1.8241 | 1.6929 |
| [a].738 |  | 1.1298 | 1.3000 | 1.2321 | 1.1066 | 1.2744 | 1.2001 |

[a]Same wings as presented in figure 2.

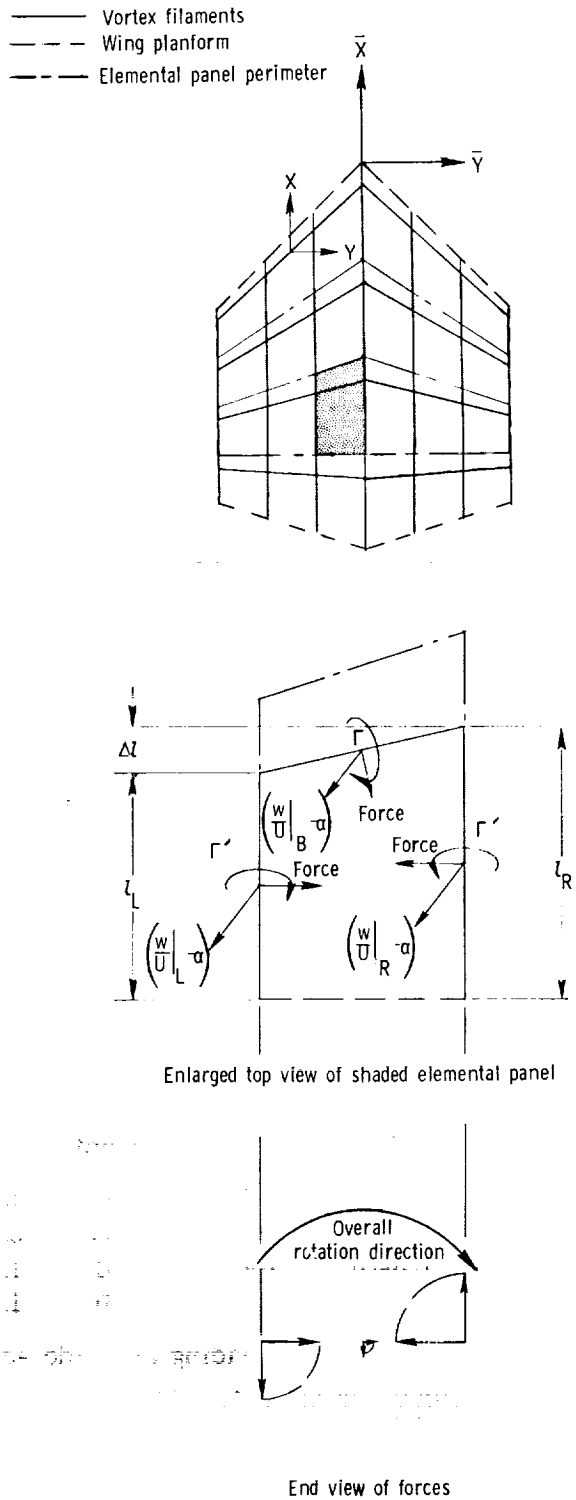
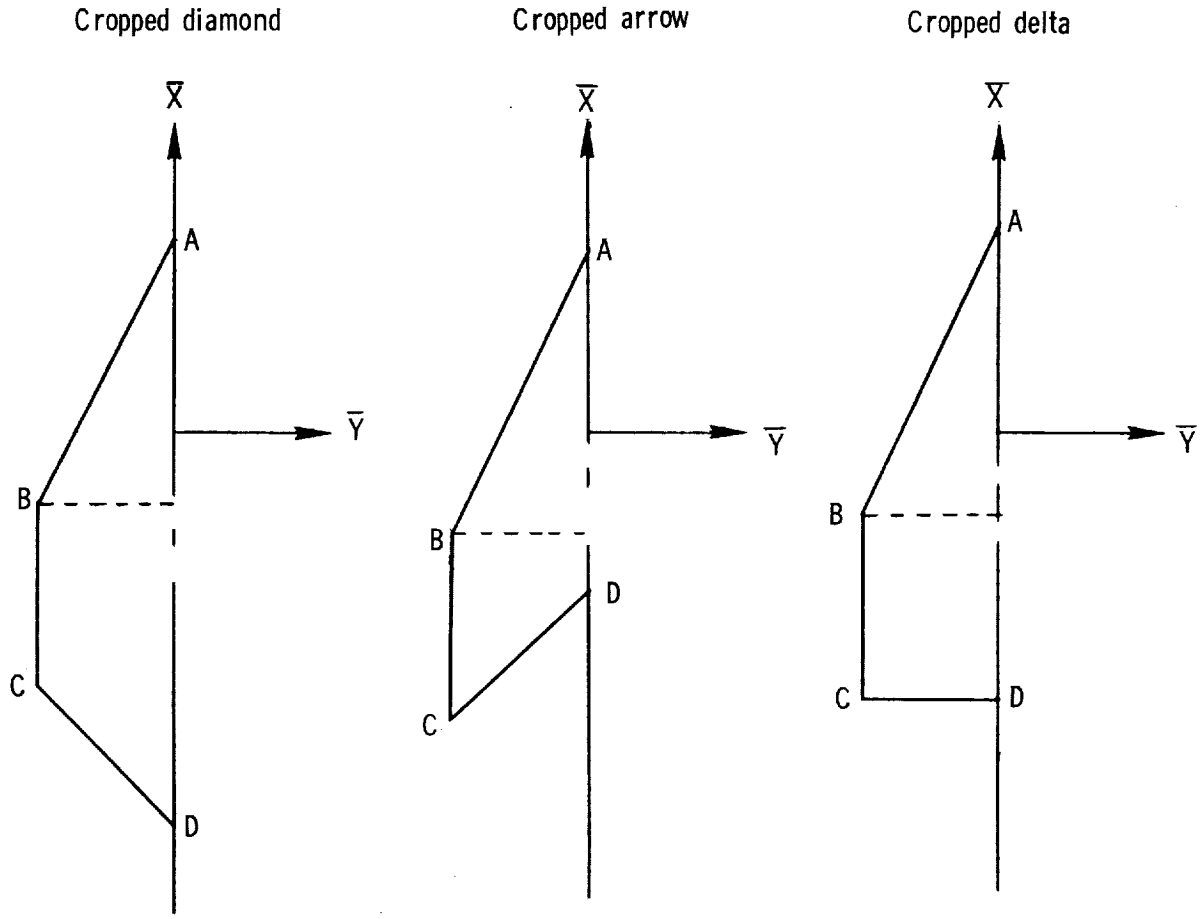



Figure 1.- General layout of axis systems, elemental panels, and horseshoe vortices for a typical wing.

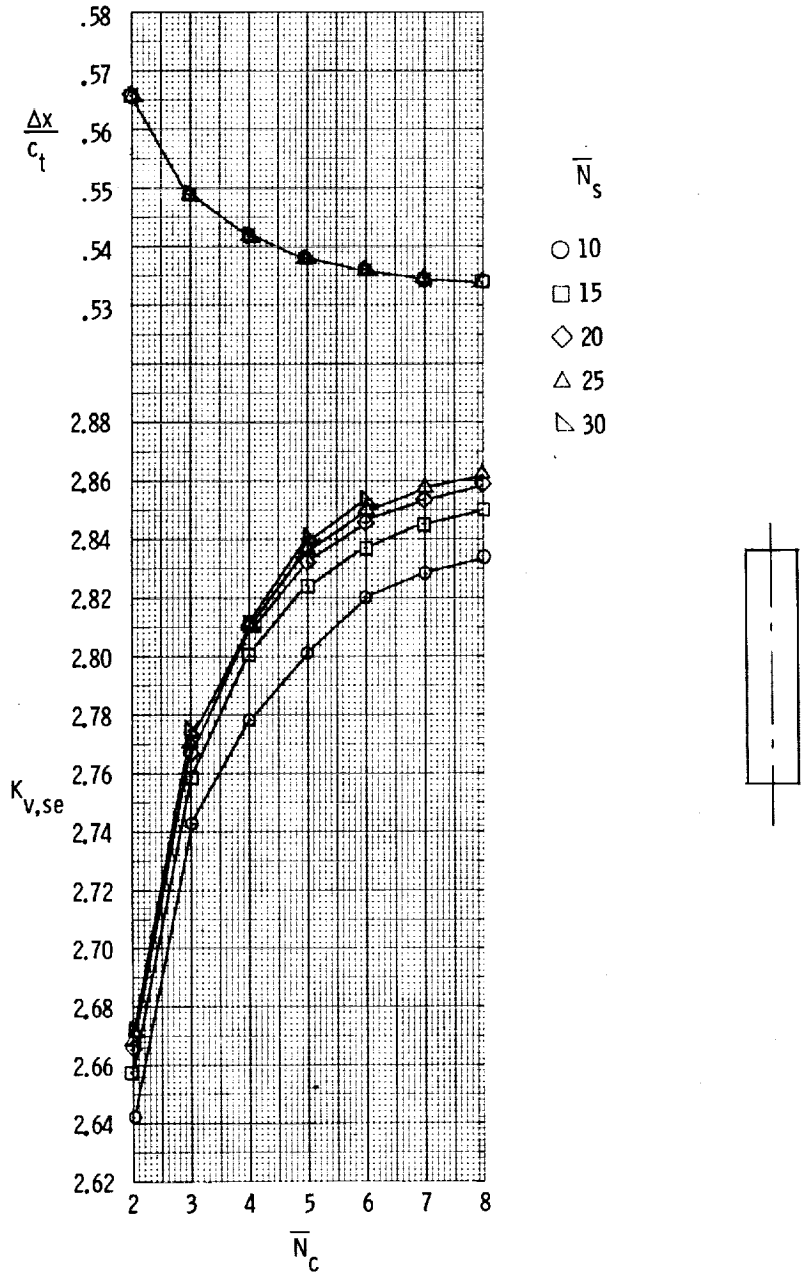



| Point | $\bar{x}$ | $\bar{y}$ |
|---|---|---|
| A | 1.54985 | 0.0 |
| B | -0.41276 | -1.0 |
| C | -1.72117 | -1.0 |
| D | -2.56025 | 0.0 |

| Point | $\bar{x}$ | $\bar{y}$ |
|---|---|---|
| A | 1.36465 | 0.0 |
| B | -0.59796 | -1.0 |
| C | -1.90637 | -1.0 |
| D | -1.06725 | 0.0 |

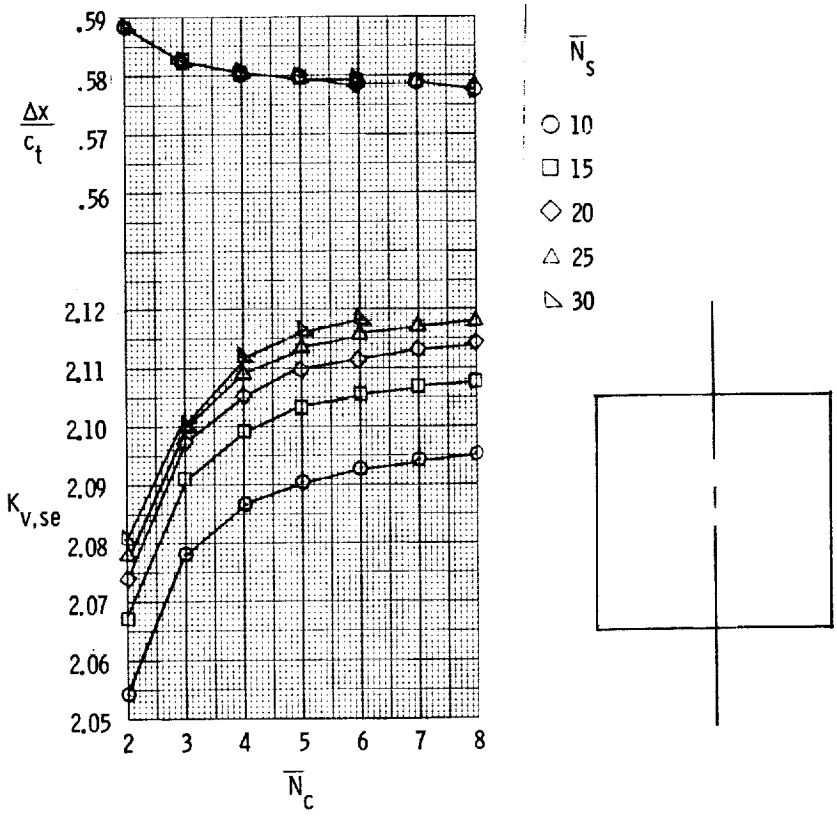
| Point | $\bar{x}$ | $\bar{y}$ |
|---|---|---|
| A | 1.44858 | 0.0 |
| B | -0.51403 | -1.0 |
| C | -1.8224 | -1.0 |
| D | -1.8224 | 0.0 |

Figure 2.- Drawings of cropped planforms. Leading and side edges are sharp. All dimensions are in centimeters.



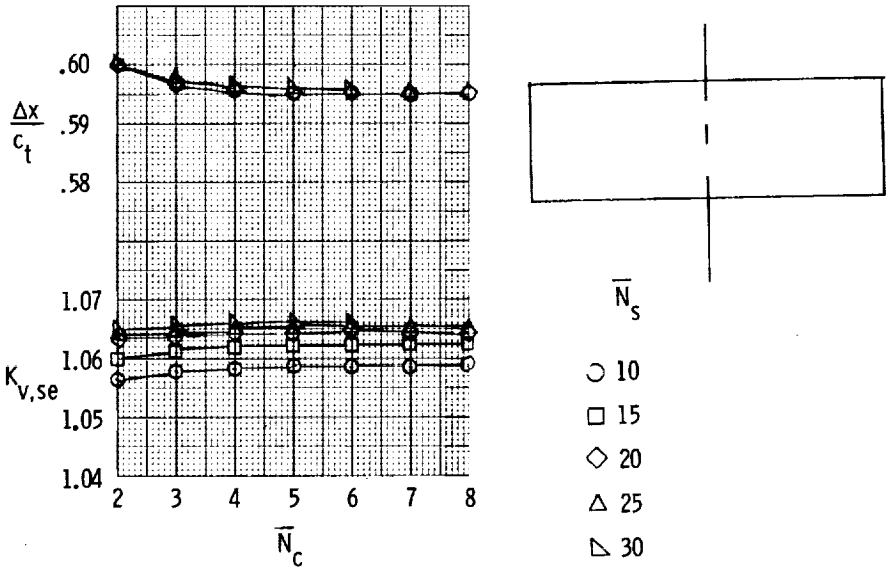

(a) A = 0.20; $\Lambda = 0^o$; $\lambda = 1.0$.

Figure 3.- Variation of $K_{v,se}$ and $\Delta x/c_t$ with $\bar{N}_s$ for simple planforms at M = 0.



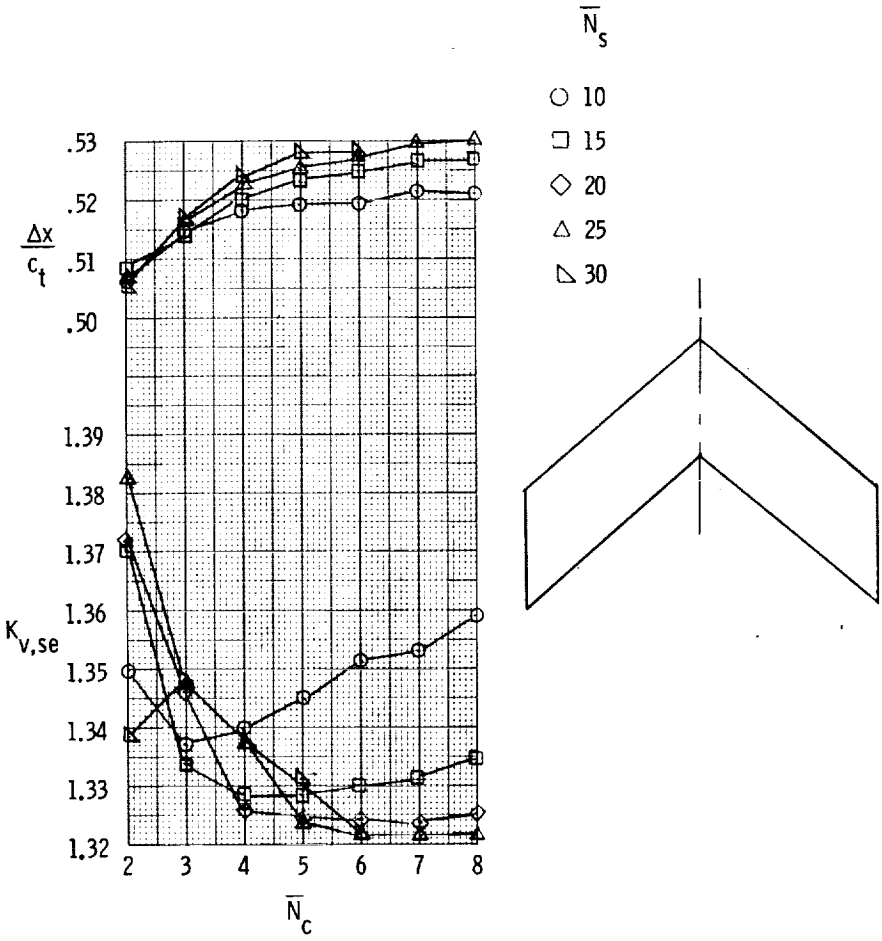

(b) A = 1.00; $\Lambda = 0^{o}$; $\lambda = 1.0$.

Figure 3.- Continued.



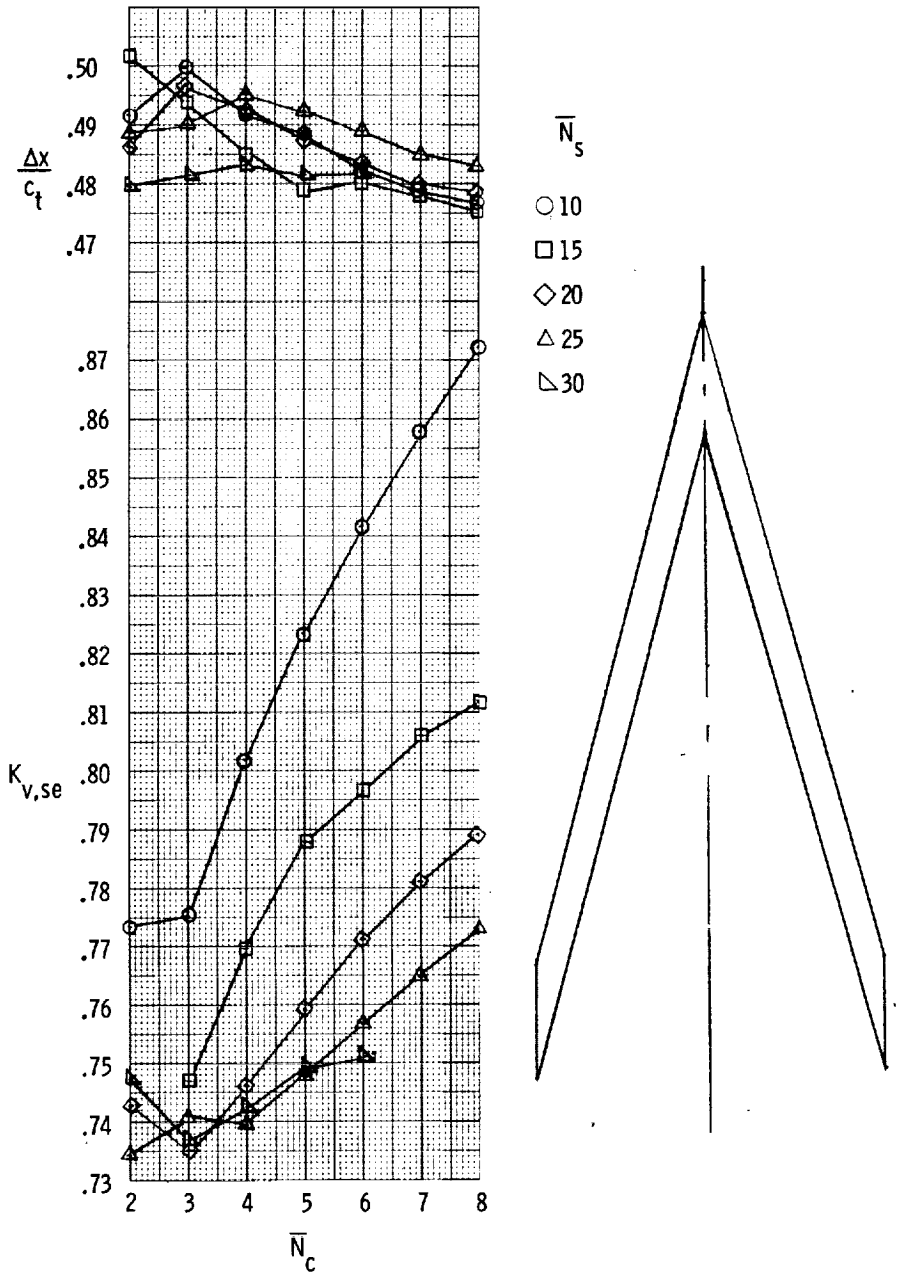

(c) A = 3.50; $\Lambda = 0^o$; $\lambda = 1.0$.

Figure 3.- Continued.



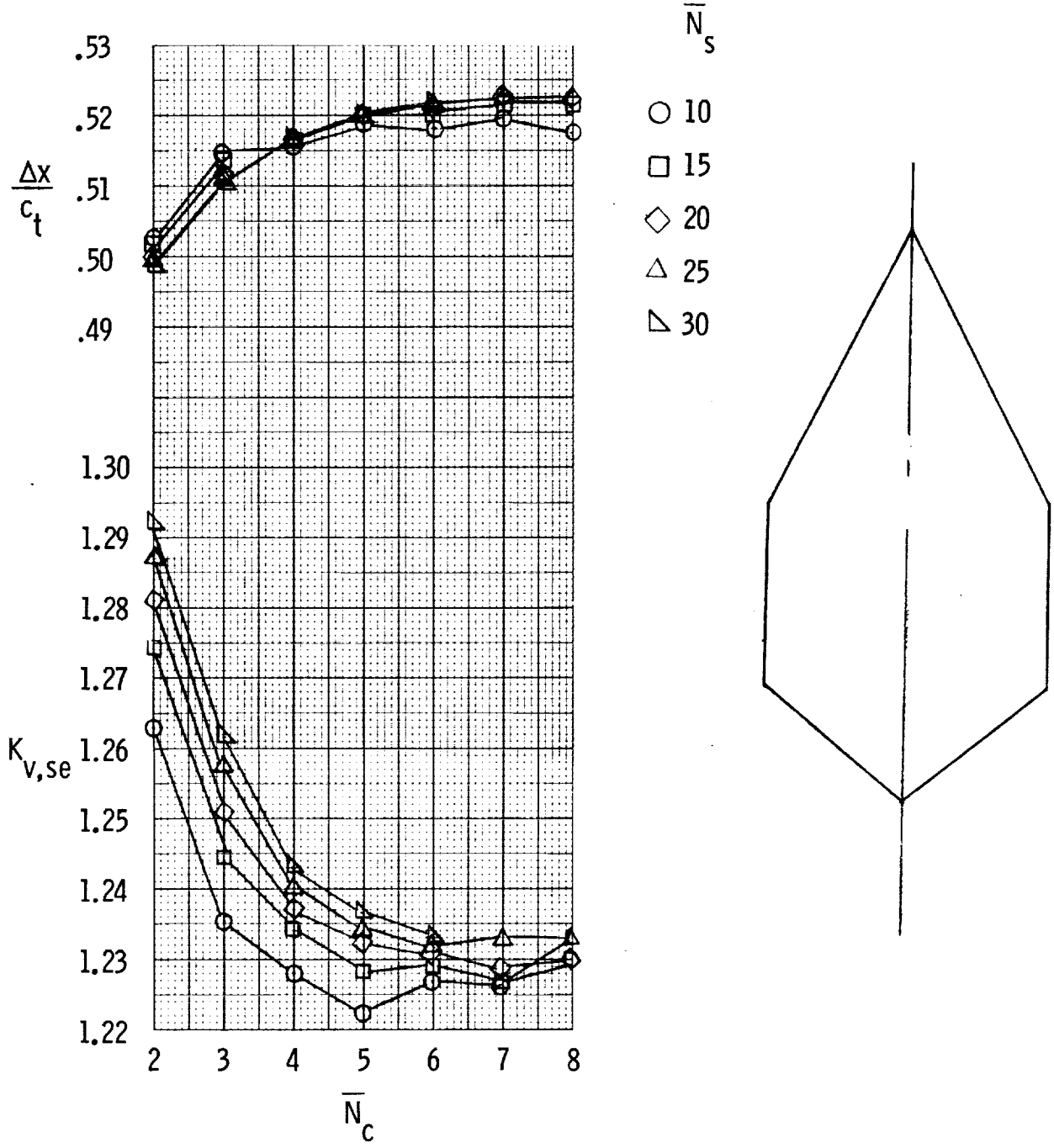

(d) A = 3.50; $\Lambda = 40^{o}$; $\lambda = 1.0$.

Figure 3.- Continued.



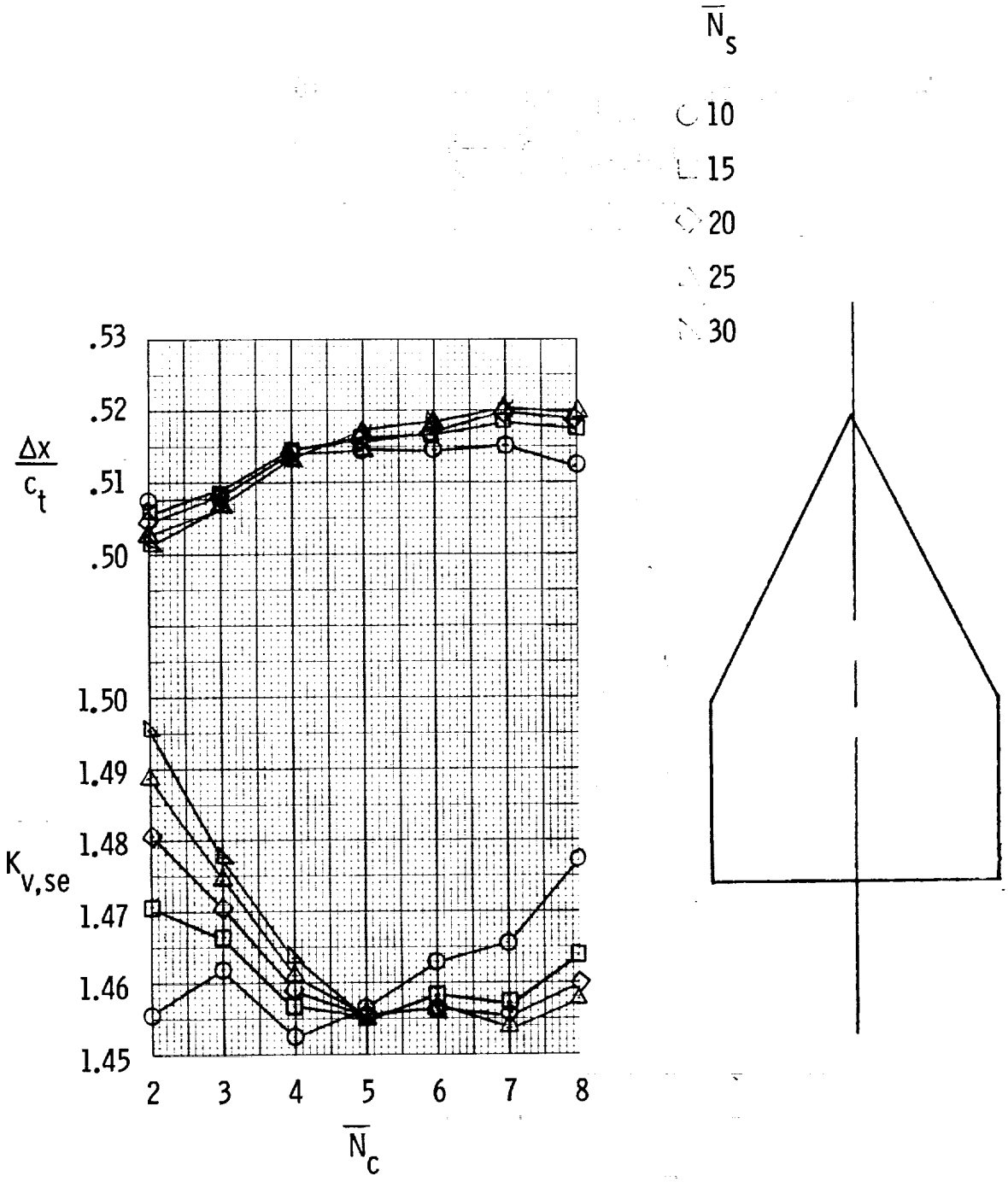

(e) A = 3.50; $\Lambda = 75^{o}$; $\lambda = 1.0$.

Figure 3.- Concluded.



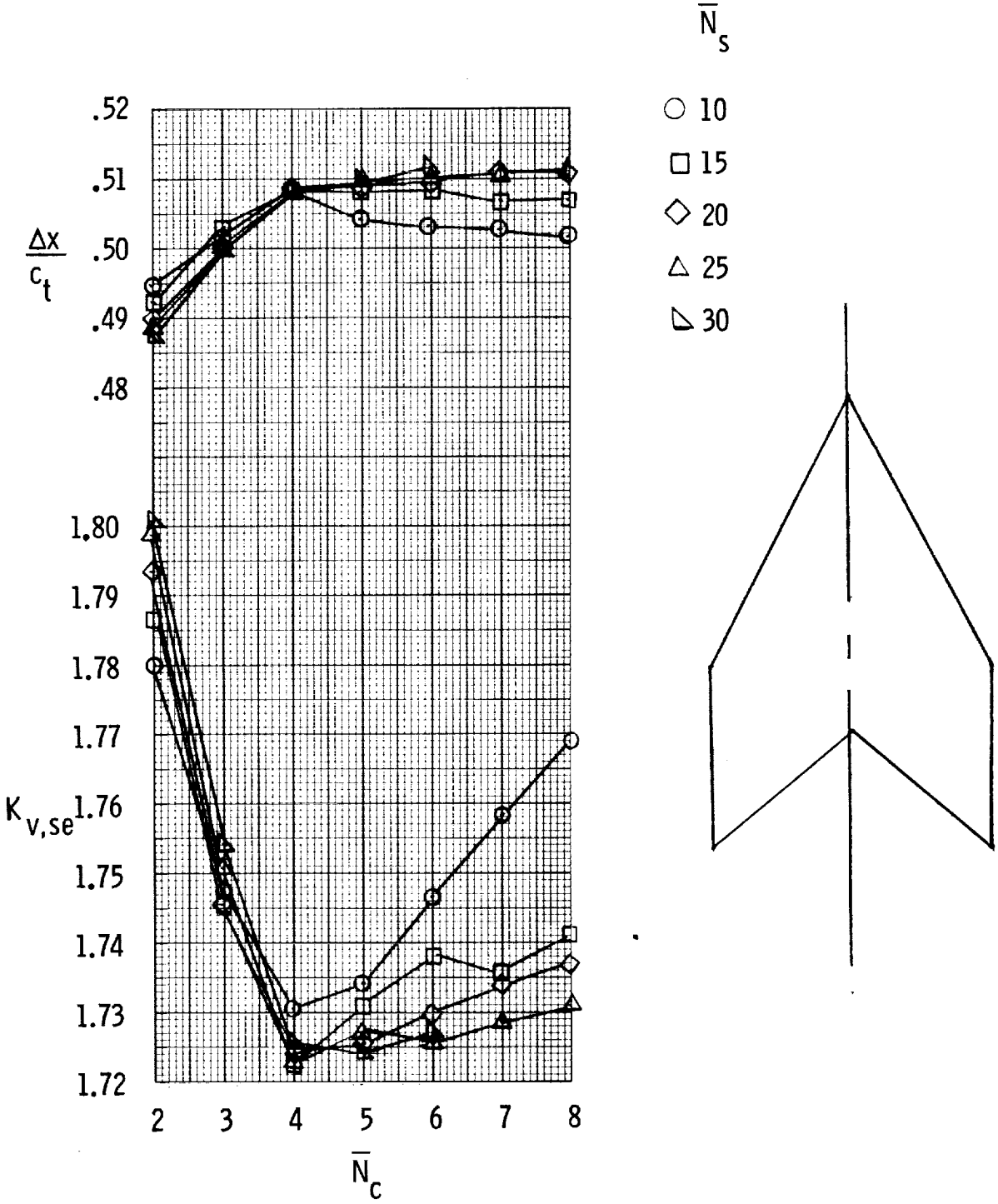

(a) Diamond; $A = 0.74$; $\Lambda = 63^{\circ}$; $\lambda = 0.32$.

Figure 4.- Variation of $K_{v,se}$ and $\Delta x/c_t$ with $\overline{N}_s$ for three cropped planforms at $M = 0$.




(b) Delta; A = 0.87; $\Lambda = 63^{o}$; $\lambda = 0.4$.

Figure 4.- Continued.




(c) Arrow; A = 1.07; $\Lambda = 63^{o}$; $\lambda = 0.53$.

Figure 4.- Concluded.

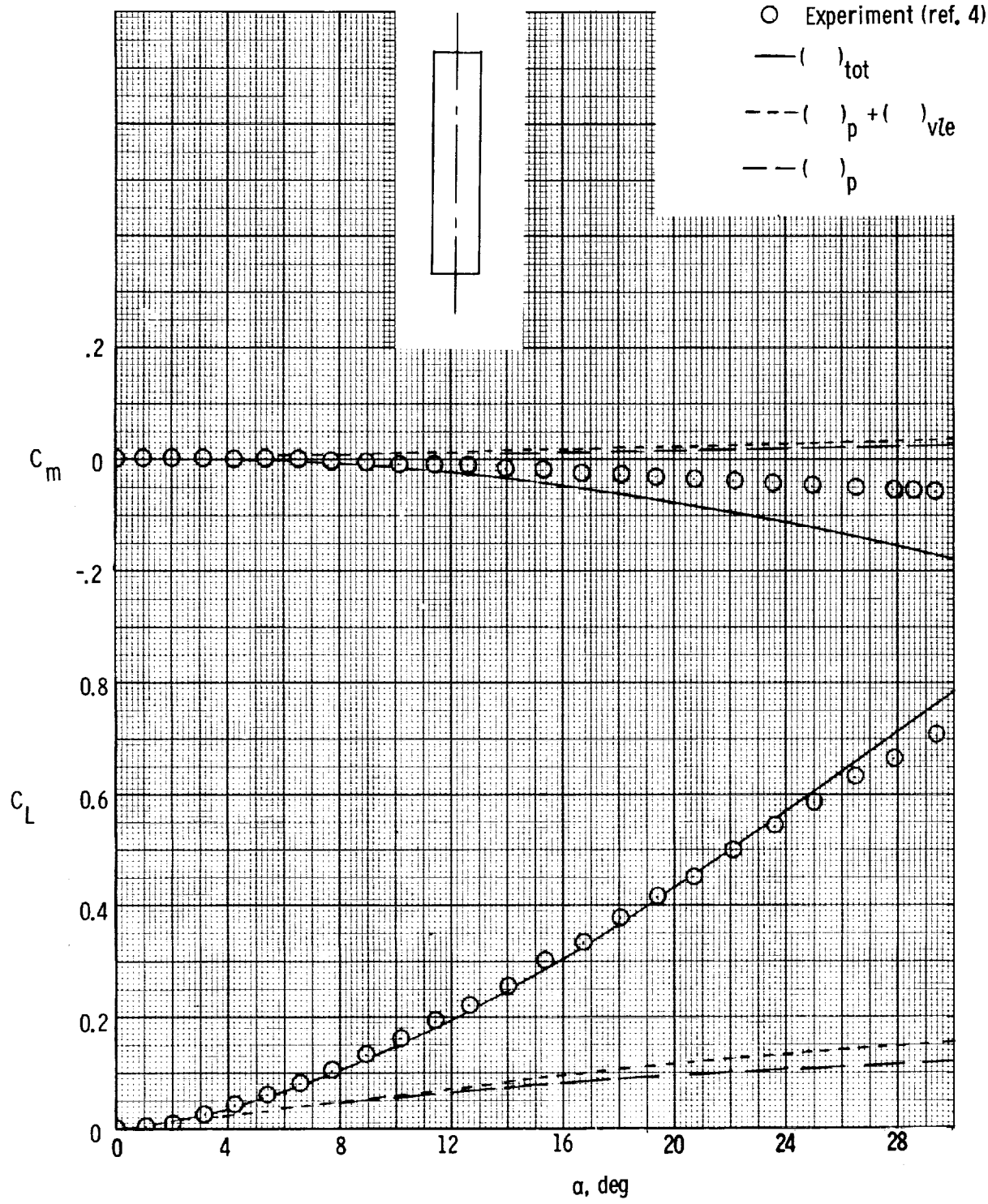



Figure 5.- Theoretical and experimental results for 0.2-aspect-ratio rectangular flat wing with sharp leading and side edges at $M = 0.20$ with $\overline{N}_c = 6$ and $\overline{N}_s = 25$.

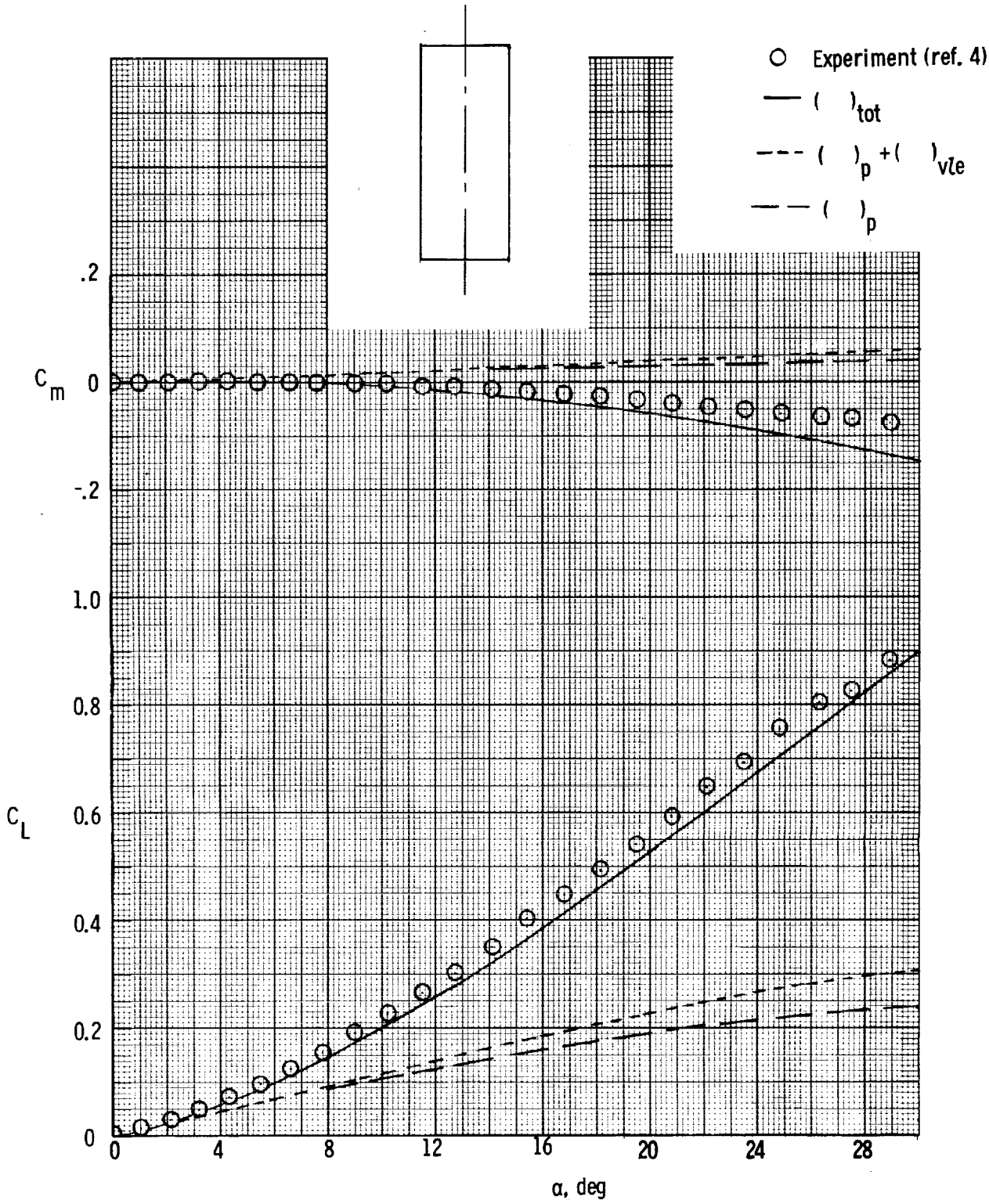



Figure 6.- Theoretical and experimental results for 0.4-aspect-ratio rectangular flat wing with sharp leading and side edges at $M = 0.20$ with $\bar{N}_C = 6$ and $\bar{N}_S = 25$.

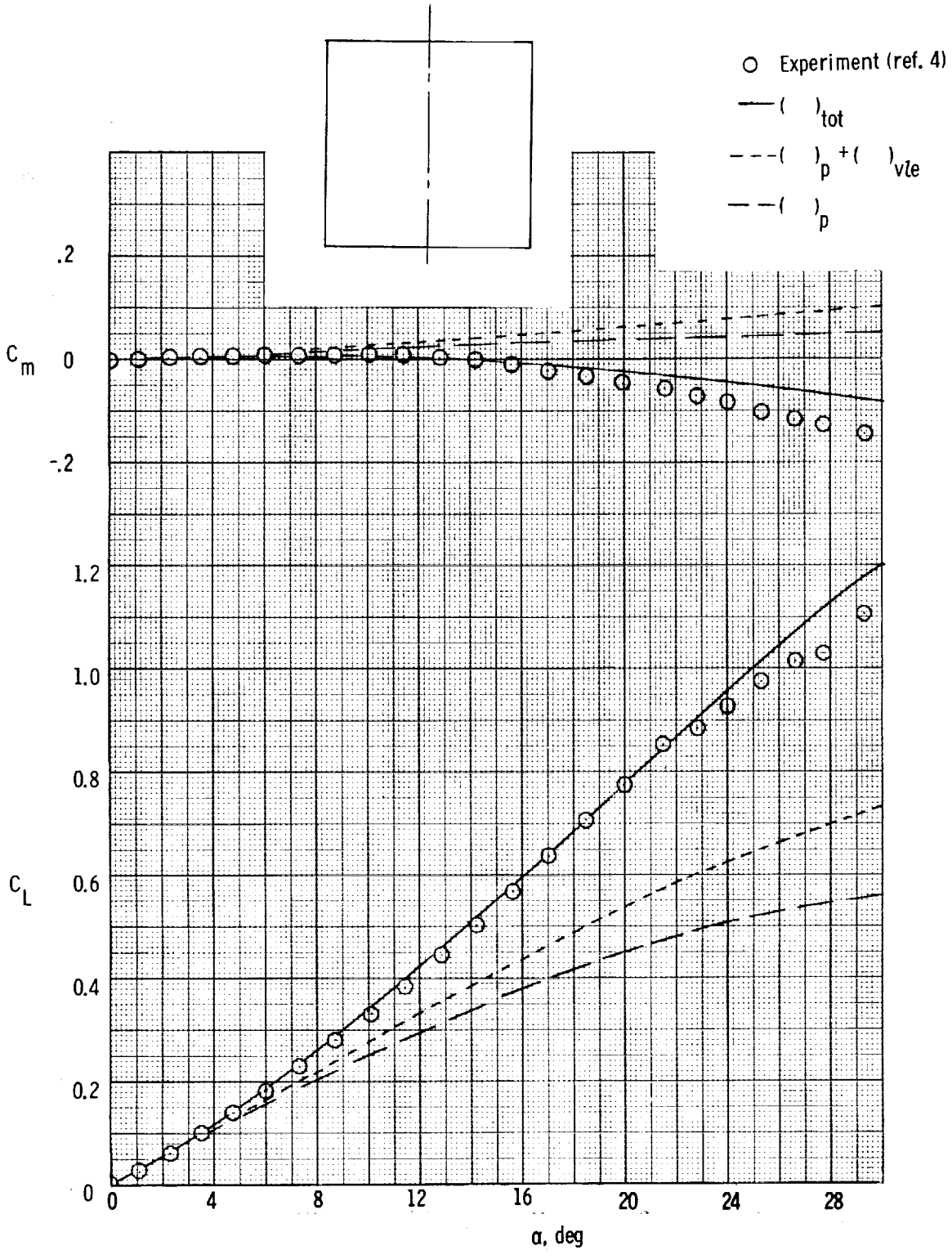



Figure 7.- Theoretical and experimental results for 1.0-aspect-ratio rectangular flat wing with sharp leading and side edges at $M = 0.20$ with $\overline{N}_C = 6$ and $\overline{N}_S = 25$.

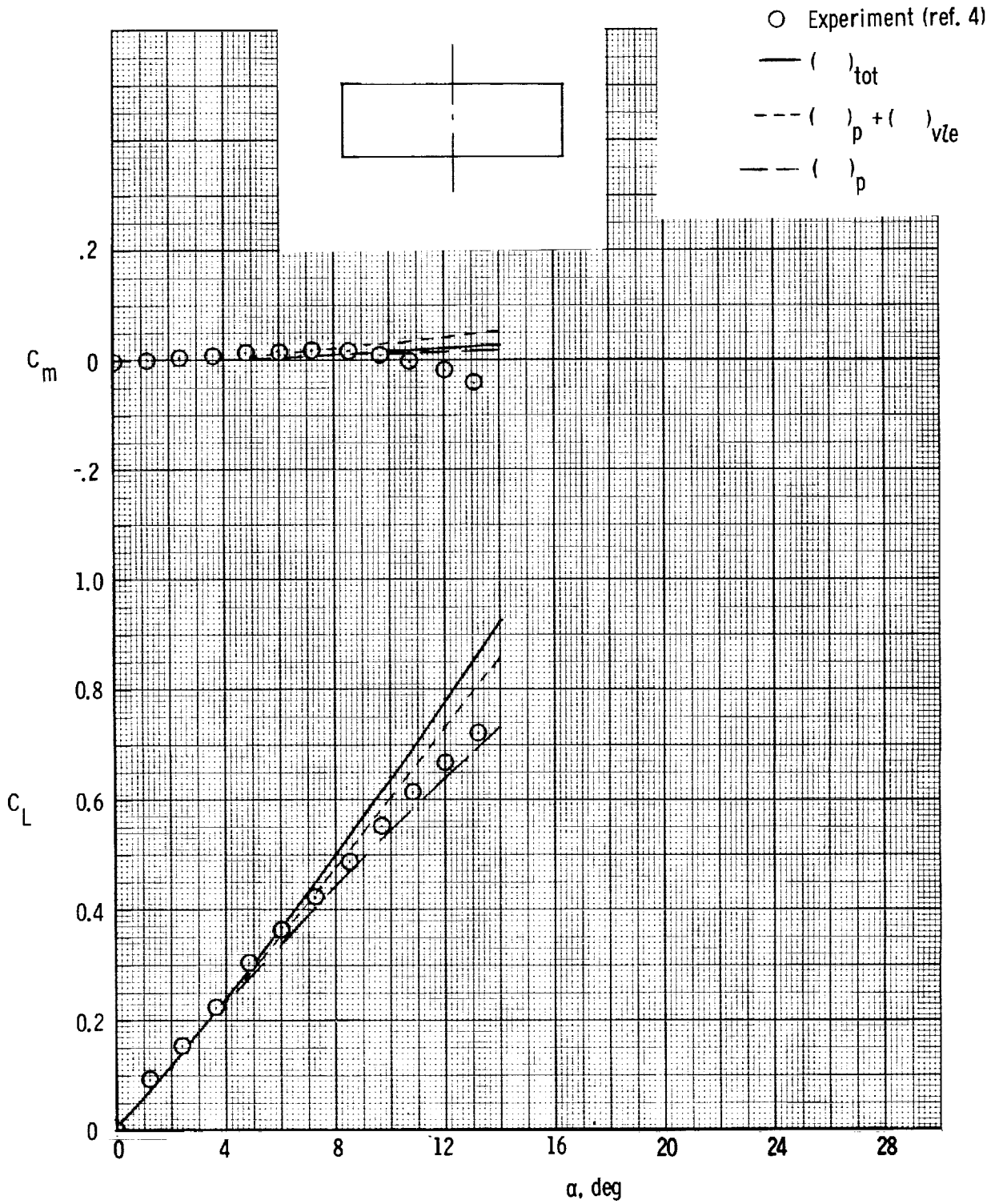



Figure 8.- Theoretical and experimental results for 3.0-aspect-ratio rectangular flat wing with sharp leading and side edges at $M = 0.20$ with $\overline{N}_c = 6$ and $\overline{N}_s = 25$.

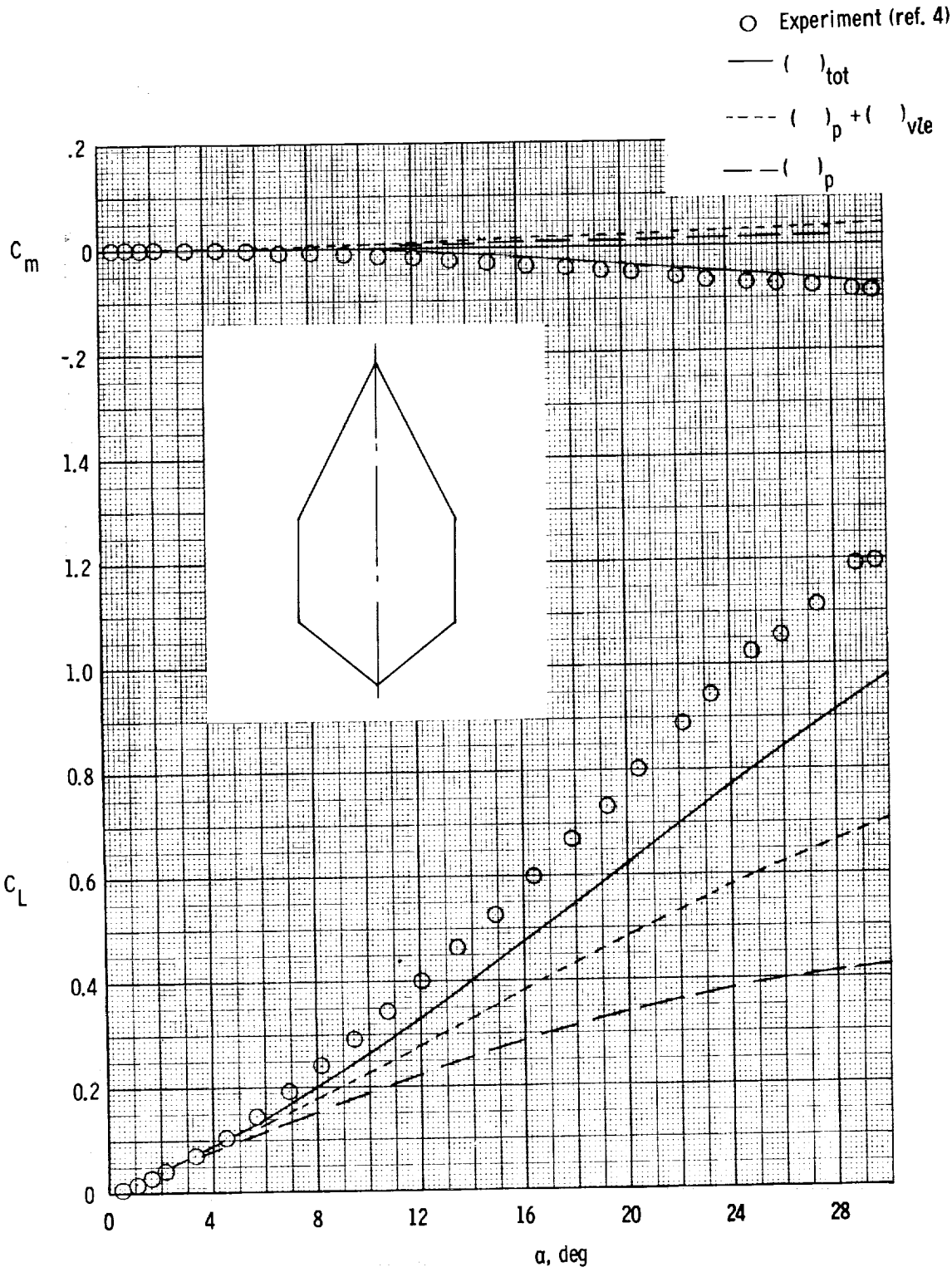



Figure 9.- Theoretical and experimental results for 0.738-aspect-ratio cropped diamond wing at $M = 0.20$ with $\overline{N}_C = 6$ and $\overline{N}_S = 25$.

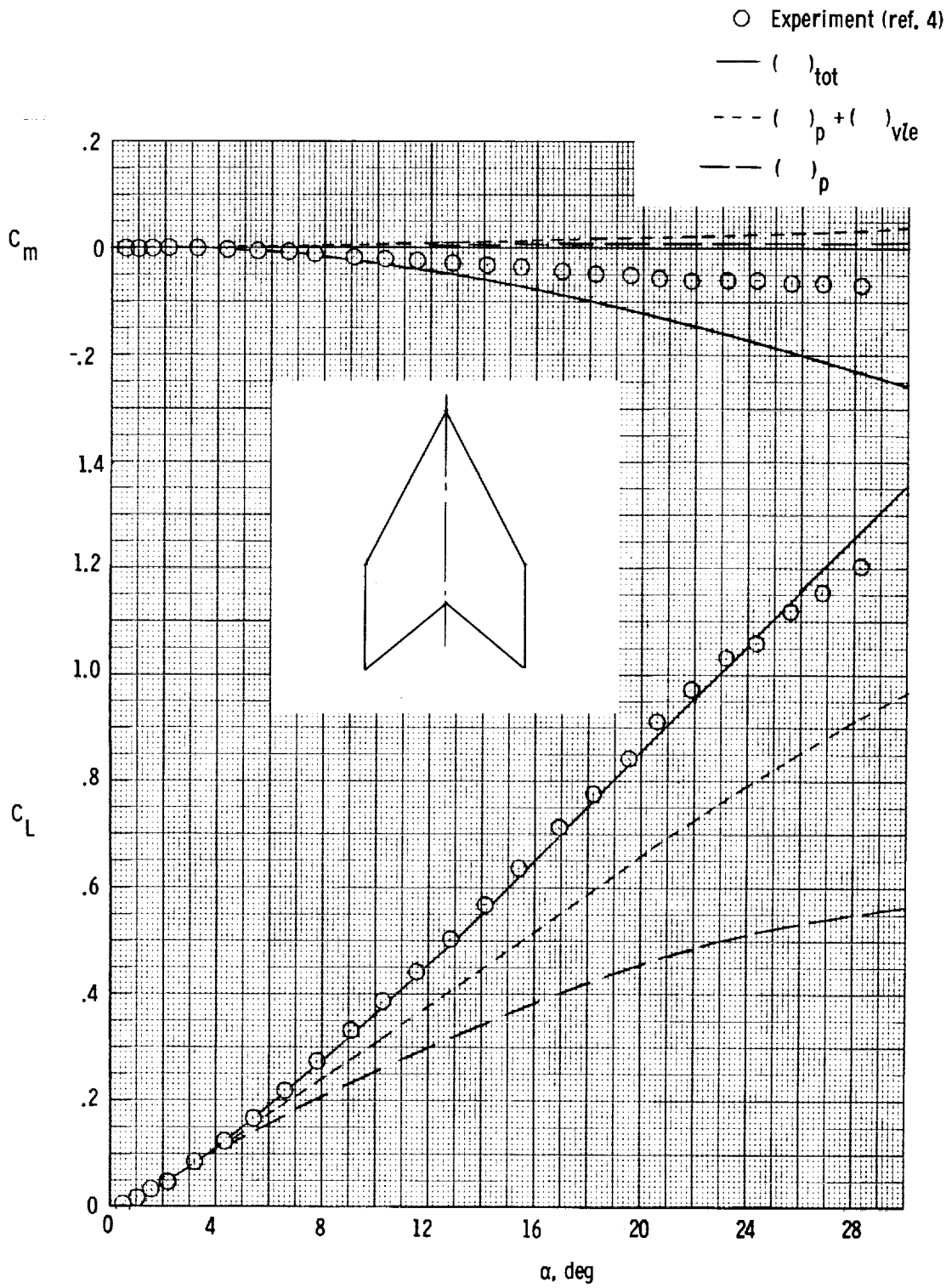



Figure 10.- Theoretical and experimental results for 1.069-aspect-ratio cropped arrow wing at $M = 0.20$ with $\overline{N}_c = 6$ and $\overline{N}_s = 25$.

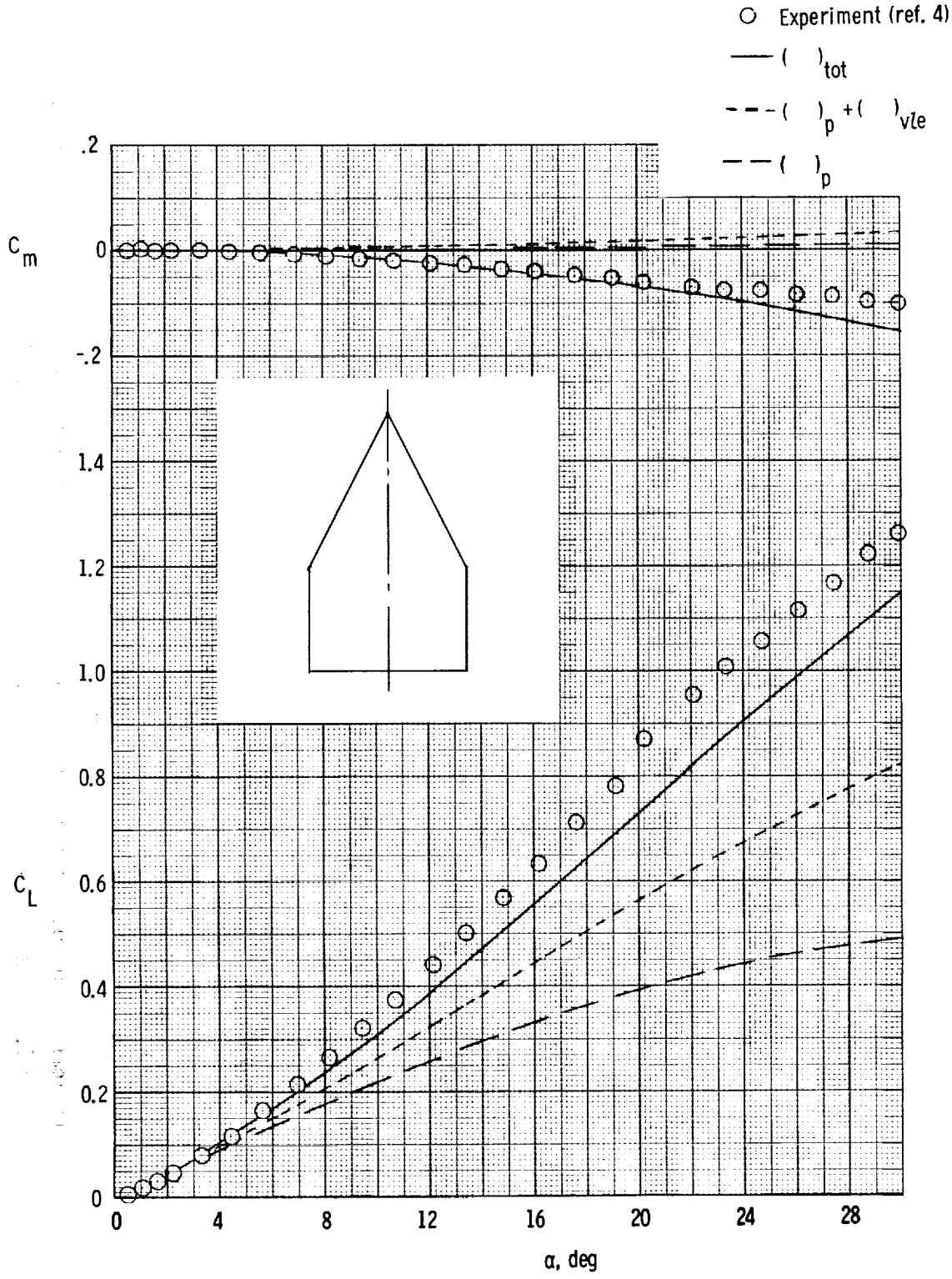



Figure 11.- Theoretical and experimental results for 0.873-aspect-ratio cropped delta wing at $M = 0.20$ with $\bar{N}_c = 6$ and $\bar{N}_s = 25$.

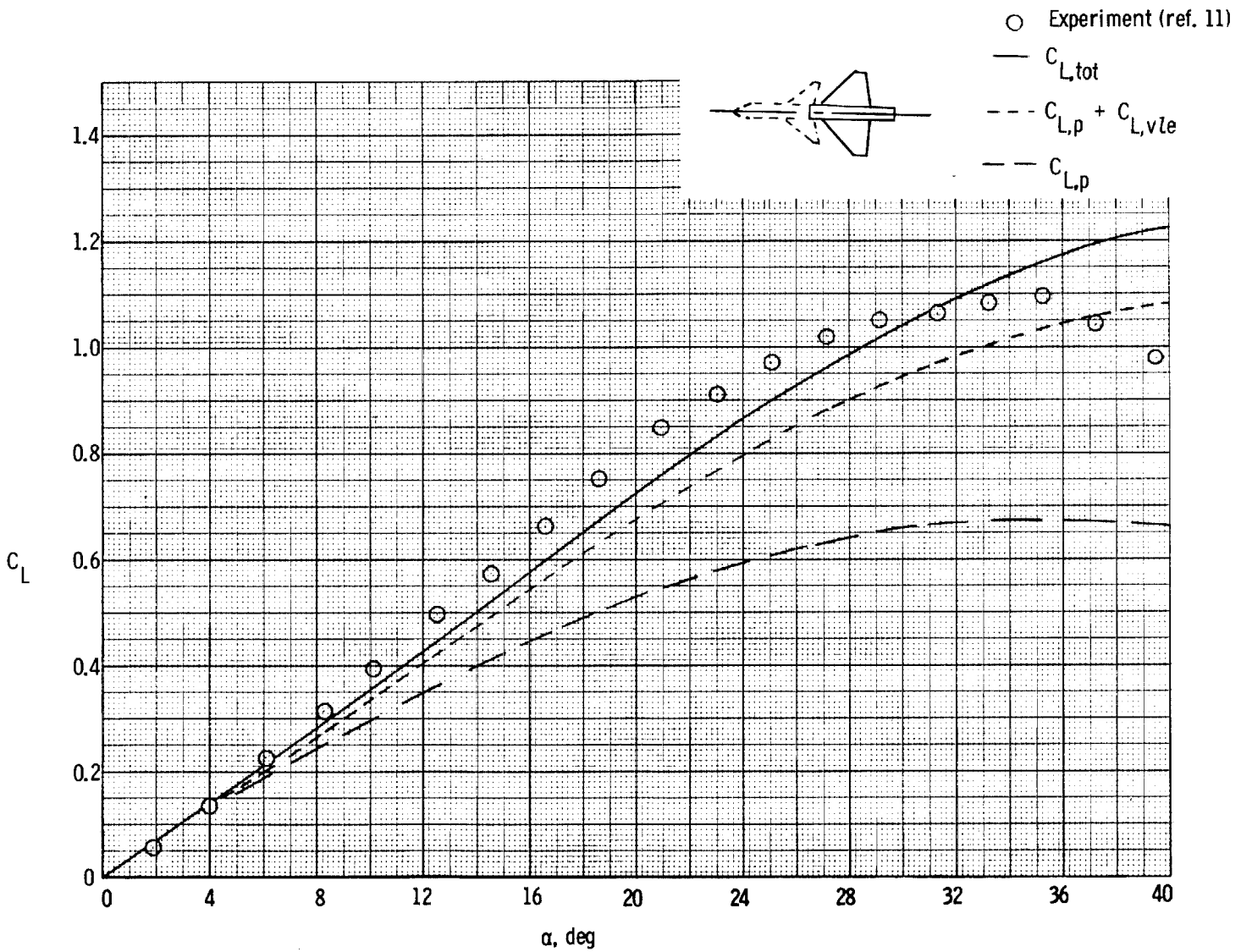



Figure 12.- Theoretical and experimental results on 44° swept wing in presence of canard in wing chord plane. $M = 0.30$ with $\overline{N}_C = 6$ and $\overline{N}_S = 12$ for canard and $\overline{N}_S = 17$ for wing.

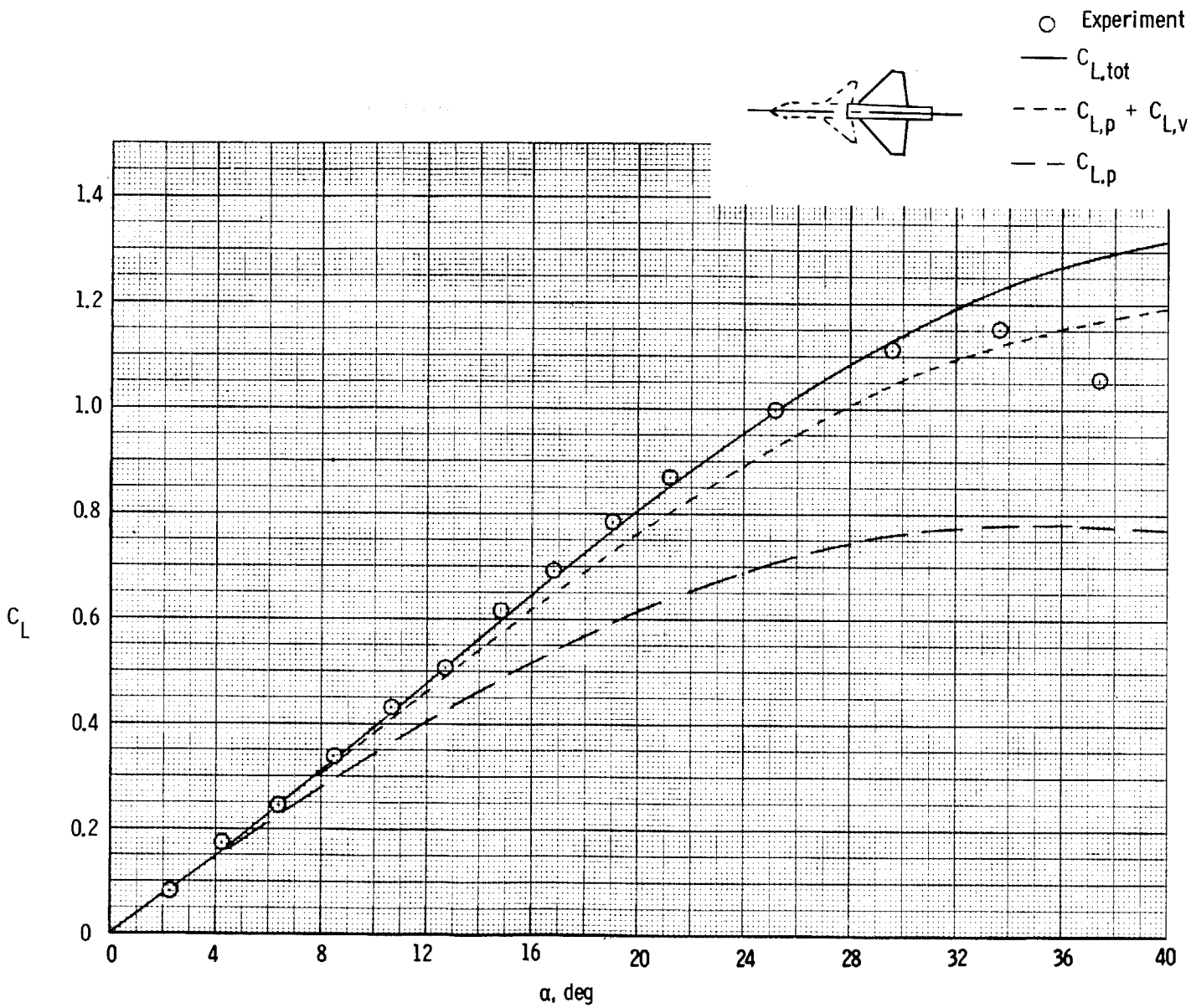



Figure 13.- Theoretical and experimental results on 44° swept wing in presence of canard above wing chord plane. $M = 0.30$ with $\overline{N}_C = 6$ and $\overline{N}_S = 12$ for canard and $\overline{N}_S = 17$ for wing.

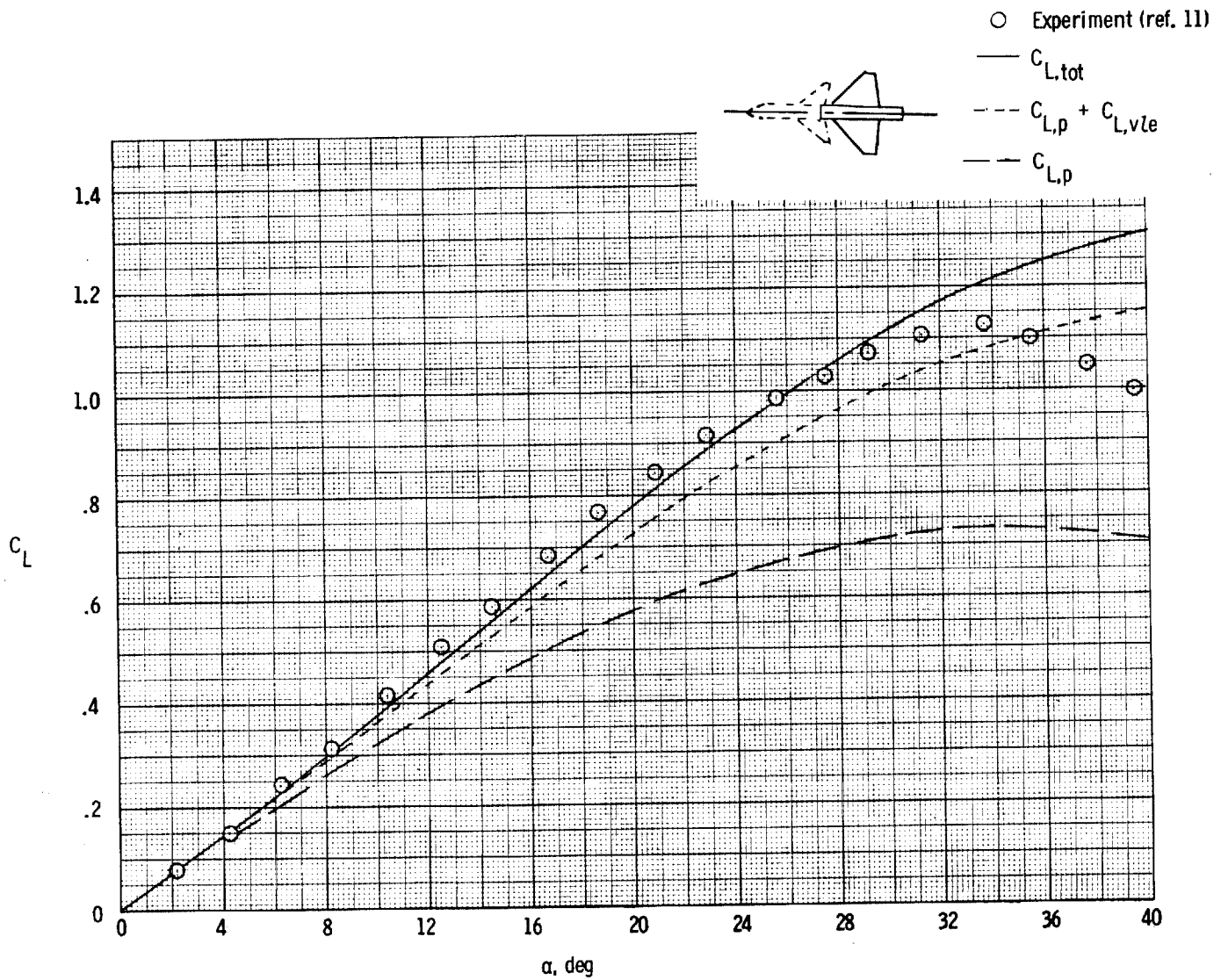



Figure 14.- Theoretical and experimental results on 44° swept wing in presence of canard with 18.6° anhedral above wing chord plane. M = 0.30 with $\overline{N}_C = 6$ and $\overline{N}_S = 12$ for canard and $\overline{N}_S = 17$ for wing.

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